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Pricing Currency Risk

Facts and Puzzles from Currency Boards

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Abstract

Schmukler and Servén investigate the patterns and determinants of the currency risk premium in two currency boards—Argentina and Hong Kong. Despite the presumed rigidity of currency boards, currency premium is almost always positive and at times very large. Its term structure is usually upward sloping, but flattens out or even becomes inverted at times of turbulence. Currency premia differ across markets. The forward discount typically exceeds the currency premium derived from interbank rates, particularly during times of crisis. The large magnitude of these cross-market differences can be the consequence of unexploited arbitrage opportunities, market segmentation, or other risks embedded in typical measures of currency risk. The premium and its term structure depend on domestic and global factors related to devaluation expectations and risk perceptions.

This paper—a product of the Macroeconomics and Growth, Development Research Group—is part of a larger effort in the group to understand how capital market and exchange rate regimes work. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Emily Khine, room MC3-347, telephone 202-473-7471, fax 202-522-3518, email address kkhine@worldbank.org. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at sschmukler@worldbank.org or lserven@worldbank.org. March 2002. (76 pages)

Pricing Currency Risk: Facts and Puzzles from Currency Boards *

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I. Introduction

Interest rate differentials, the spread between local interest rates and international interest rates, are a key variable for emerging countries. Spreads are usually positive for these countries, which implies that they face a higher cost of capital than developed economies. Interest rate differentials vary substantially over time and increase in periods of local and foreign financial turmoil, and this has lead to "sudden stops" of economic activity in emerging economies.[1] Lower spreads typically translate into lower borrowing costs, for both the public and private sector, and higher growth. For that reason, the ways to achieve a reduction in interest rate differentials have been recently at the center of academic debate and have been a major concern for policy makers

Conceptually, the total differential between interest rates on domestic currency-loans issued by local borrowers and those on foreign-currency loans issued by foreign borrowers reflects both country and currency premia. The former refers to the gap between the borrowing costs of domestic and foreign borrowers in a common currency. The latter, on which this paper focuses, refers to the gap between the domestic-currency and foreign-currency interest rates faced by a given borrower; it is often called "currency risk premium" and, less precisely but more popularly, currency risk.

Of the two components of interest rate differentials, the country risk premium has been intensively studied, perhaps due to the availability of daily cross-country data. Indexes of yield spreads on emerging market bonds (EMBIs) are compiled by JP Morgan. Data on primary issues also exist. The literature has studied the behavior of yield spreads

[1] See Calvo (1998).

including their time pattern, determinants, and cross-country comovement.[2] Some papers also study the country risk premium in relation to the currency premium.[3]

The other component of interest rate differentials, the currency premium, has received less direct empirical attention in the context of emerging economies. Still, the currency premium is relevant to several strands of the literature – like those on exchange rate determination, uncovered interest parity, and real interest parity. The present study relates directly to at least four different strands of the international finance literature: the debate on the choice of exchange rate regime, the assessment of economic performance under currency boards, the term structure of currency premia, and covered interest parity.

First, the debate on the choice of exchange rate regime pays particular attention to the currency premium. Participants in this debate, which intensified during the currency crises of the 1990s, have claimed that countries should opt for either hard pegs or floating regimes. Proponents of hard pegs argue that, other things equal, the adoption of a rigid parity – such as a currency board – should reduce the currency premium, even eliminating it entirely if the peg is viewed as irrevocable. In this view, hard pegs are thought to be credible and transparent, and this yields financial stability and low inflation. As a consequence, hard pegs would reduce the level of domestic interest rates.[4] Credible hard pegs would also reduce the probability of currency attacks and contagion effects.

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[2] See, for example, Edwards (1984), Edwards (1986), Favero, Giavazzi, and Spaventa (1997), Eichengreen and Mody (1998), Kamin and von Kleist (1999), Mauro, Sussman, and Yafeh (2000), Kaminsky and Schmukler (2001), Merrick (2001), and Rigobon (2001).

[3] See Domowitz, Glen, and Madhavan (1998), Sturzenegger and Powell (2000), Didier and Garcia (2001), and Druck, Moron, and Stein (2001).

[4] Note, however, that even if the currency premium declines the country premium could rise if adopting a rigid peg is perceived to weaken the country's solvency. In such case, the net effect on the level of borrowing cots would be ambiguous.

But as Edwards (2000) suggests, the currency premium can still be significantly positive even in hard pegs, if they are not fully credible.

Second, the debate on exchange rate regimes has generated a related literature on economic performance under currency boards. Ghosh, Gulde, and Wolf (1998) find that currency boards are associated with better inflation performance and higher output growth. Kwan and Lui (1996) argue that currency boards tend to slow down output growth but reduce inflation. They also claim that currency boards might result in higher output volatility than flexible regimes. Rivera Batiz and Sy (2000) argue that currency boards yield more credibility and better economic performance than simple pegs. Hausmann (2001) discusses the conditions that might help alleviate potential problems due to the rigidity of currency boards. Calomiris and Powell (2001) describe how the Argentine currency board helped in the development of the financial system.

The third strand of the literature relevant to this paper is the one that studies the term structure of currency premia. The term structure reflects markets' perception of depreciation and exchange risk at different horizons, and has been studied mostly in the literature on target zones. For example, Svenson (1991) shows that under a credible target zone the absolute value of the interest rate differential is decreasing in the time to maturity, since the expected depreciation until maturity is bounded by the exchange rate band. Bartolini and Bodnar (1992) study the term structure of forward premia to assess the implied credibility of the French/German target zone under the European Monetary System. Weak currencies are found to be associated with upward-sloping forward premia, as investors forecast a further depreciation of the currency over the next periods. Their results also show that the short-term premium fluctuates more than the long-term premium. Domowitz, Glen, and Madhavan (1998) examine the term structure of the currency premium in the case of Mexico up to the Tequila crisis. They show that the term premium turned negative before and during the crisis.

The fourth strand of the literature directly relevant to this paper is the one that studies covered interest parity. This literature shows that, in the absence of country barriers or other risks, interest rate differentials are equal to the forward discount implied by the future and spot exchange rates. This fact is generally supported by the literature on industrial economies. The evidence for emerging markets is much more limited and concentrated on few countries.[5]

The present paper sheds new light on these strands of the international finance literature by providing a comprehensive characterization of the currency premium in two currency boards, Argentina and Hong Kong. Focusing on these two economies has two major advantages. First, these two currency boards have a rich history, which permits analyzing how domestic and international events impact on the currency premium. Second, these two cases offer a wide range of data not available for other economies.

This paper explores five major dimensions of the currency premium. First, we provide an analytical characterization of the various components of the total interest differential and, in particular, of the currency premium. We also draw a distinction between "strict" and "broad" versions of covered interest parity, that has been overlooked in much of the empirical literature. Second, we assess the extent to which hard pegs have in fact resulted in low and/or stable currency premia, an aspect of currency boards that

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[5] See, for example, Branson (1969), Frenkel and Levich (1977), Deardorff (1973), Dooley and Isaard (1980), Giavazzi and Pagano (1985), Artis and Taylor (1990), Frankel (1992), Chinn and Frankel (1994), Obstfeld (1995), and Kumhof (2000).

has so far received little attention in the debate on exchange rate regimes. We document the time pattern of the currency premium and its response to major domestic and foreign events. Third, we study the term structure of the currency premium in different markets – the money market and the foreign exchange market. We characterize its behavior during tranquil and turbulent times to gauge investors' expectations about the future of rigid currency pegs. This is possible because in these economies the most important financial contracts are denominated in both local currency and U.S. dollars. Fourth, we show how different financial instruments embody diverging assessments of the currency premium, particularly at times of financial stress. These cross-market discrepancies pose a puzzle that might reflect market segmentation, unexploited arbitrage opportunities, or the presence of other risks embedded in the commonly used measures of currency risk. Fifth, we study the determinants of the currency premium and its term structure, using detailed daily domestic and international financial data as well as political and economic events.

The rest of the paper is organized as follows. Section II provides a simple analytical framework for the paper. Section III documents the empirical regularities of the currency premium and its term structure in Argentina and Hong Kong over time and across instruments and maturities. The section also presents information on the institutional features of forward markets. Section IV empirically studies the determinants of the premium and its term structure. Section V concludes. The appendix assesses the extent of cross-market differences in currency premia.

II. A simple analytical framework

Consider the interest differential between assets that may differ in terms of issuer, currency of denomination, and jurisdiction of issue – but are identical in other respects. Formally, let $R_{t,k}$ denote the annualized gross yield (i.e., one plus the interest rate) at time t on local-currency debt issued in the home country with k-period maturity; let $R^{*}_{t,k}$ denote the gross yield on foreign-currency debt of the same maturity issued at home by the same debtor (or, more precisely, posing identical default risk as the local-currency debt); and let $R^{*f}_{t,k}$ denote the gross yield paid abroad on foreign-currency debt with the same maturity, issued by some benchmark foreign debtor (in the context of sovereign debt, typically taken to be the U.S. government). To break down the total yield differential into its two components we start from the identity

$$\frac{R_{t,k}}{R^{*f}_{t,k}} = \frac{R_{t,k}}{R^{*}_{t,k}} \frac{R^{*}_{t,k}}{R^{*f}_{t,k}}. \qquad (1)$$

Taking logs, letting $i_{t,k} = \ln(R_{t,k})$, and similarly with the other yields, we can write

$$\left(i_{t,k} - i^{*f}_{t,k}\right) = \underbrace{\left(i_{t,k} - i^{*}_{t,k}\right)}_{\text{currency premium}_{t,k}} + \underbrace{\left(i^{*}_{t,k} - i^{*f}_{t,k}\right)}_{\text{country premium}_{t,k}} \qquad (2)$$

II.a The currency premium

Let's ignore for the moment the country premium and focus on the currency premium. The latter refers to the difference between the returns on two securities identical in all respects except for their currency denomination – i.e., they are issued in the same jurisdiction and involve identical (or are free from) default risk.

Speculation across these two assets by risk-neutral investors would result in the well-known uncovered interest parity condition:

$$R_{t,k} = R^*_{t,k}\left[\frac{E_t S_{t+k}}{S_t}\right]^{1/k}, \qquad (3)$$

where $E_t S_{t+k}$ is the expectation at time t of the exchange rate at time $t+k$, and the exchange rate is defined as local currency per unit of foreign currency. Letting $\Delta s^e_{t,k}$ denote the (per period) anticipated percentage change in the spot exchange rate $\frac{1}{k}\ln\left[\frac{E_t S_{t+k}}{S_t}\right]$, we can rewrite (3) as

$$\left(i_{t,k} - i^*_{t,k}\right) = \Delta s^e_{t,k}, \qquad (4)$$

so that the currency premium equals the anticipated rate of change of the exchange rate. A considerable empirical literature has investigated the consistency of the data with (3) or its equivalent (4). The frequent failure of uncovered interest parity to hold in practice has been traced to two main sources (Lewis 1995): persistent expectation errors – due to irrationality, agent heterogeneity, or peso problems – and risk aversion, what is more important for our purposes.

Under risk aversion, investors demand a compensation for the risk of exchange rate changes, and in such case the interest differential (4) has to be expanded to include also an exchange rate risk premium. Thus, in the general case the currency premium consists of two components:

$$\underbrace{\left(i_{t,k} - i^*_{t,k}\right)}_{\text{currency premium}_{t,k}} = \underbrace{\Delta s^e_{t,k}}_{\text{anticipated devaluation}_{t,k}} + \underbrace{errp_{t,k}}_{\text{exchange risk premium}_{t,k}} \qquad (5)$$

where *errp* denotes the exchange risk premium. There is a literature that attempts to break down empirically the currency premium into these two components, using survey data on exchange rate forecasts (Frankel 1991) or Kalman filter techniques (Wolf 1987, Cheung 1993).

II.b The country premium

The country premium can also be broken down into two terms: the pure default premium and what we shall label the "onshore premium." These two premia are associated with default and transaction risks related to cross-country transactions. The pure default premium refers to the return differential between identical assets issued in the same jurisdiction by two different borrowers posing different default risk. Hence it reflects the possibility that borrowers may not honor their debts. In turn, the onshore premium refers to the return differential between assets issued in two different jurisdictions (onshore and offshore) by the same borrower, and reflects the cost and risk derived from shifting assets across jurisdictions (Aliber 1973). Hence, it relates to ingredients such as capital controls, differential taxation, commissions, and fees, as well as the risk of changes in regulations (e.g., changes in the status of capital controls) or in the market conditions that affect the transaction cost. Further, it may also reflect the differential legal treatment of default in the home and foreign jurisdictions – which can make a given borrower more likely to default in one jurisdiction (typically onshore) than in the other (offshore).[6] Formally:

$$\frac{R^{*}_{t,k}}{R^{*f}_{t,k}} = \frac{R^{*}_{t,k}}{{}^{offshore}R^{*}_{t,k}} \frac{{}^{offshore}R^{*}_{t,k}}{R^{*f}_{t,k}}, \quad (6)$$

[6] Default regulations in major financial centers such as New York and London are stricter than those in many emerging markets, making the costs of default on offshore instruments much larger than those on onshore instruments. This issue has recently become prominent in the context of external payments difficulties, such as the Ecuador default and Argentina's "debt swap."

where ${}^{offshore}R^{*}_{t,k}$ denotes the gross yield on foreign-currency instruments issued abroad by domestic debtors with the same characteristics as those issued at home (which yield $R^{*}_{t,k}$). Taking logs and using the same notation as before, we have

$$\underbrace{\left(i^{*}_{t,k} - i^{*f}_{t,k}\right)}_{\text{country premium}_{t,k}} = \underbrace{\left(i^{*}_{t,k} - {}^{offshore}i^{*}_{t,k}\right)}_{\text{onshore premium}_{t,k}} + \underbrace{\left({}^{offshore}i^{*}_{t,k} - i^{*f}_{t,k}\right)}_{\text{pure default premium}_{t,k}} . \quad (7)$$

II.c Strict and broad covered interest parity

If a forward exchange market exists, then risk-free arbitrage between domestic and foreign-currency securities yields what we shall label the "broad" version of the covered interest parity condition:

$$R_{t,k} = R^{*f}_{t,k}\left[\frac{F_{t,t+k}}{S_t}\right]^{1/k}, \quad (8)$$

where $F_{t,t+k}$ is the k-period forward exchange rate at time t. This is a broad version of covered interest parity because the assets involved may differ in currency of denomination, issuer (domestic versus foreign) and jurisdiction of issue (onshore versus offshore). As before, equation (8) can be rewritten to show that the interest rate differential equals the forward discount:

$$\left(i_{t,k} - i^{*f}_{t,k}\right) = fd_{t,k}, \quad (9)$$

where $fd_{t,k} = \frac{1}{k}\ln\left[\frac{F_{t+k}}{S_t}\right]$. Thus, under broad covered interest parity there are in principle two identical measures of the currency premium, $\left(i_{t,k} - i^{*f}_{t,k}\right)$ and $fd_{t,k}$.

A considerable empirical literature tests the broad version of covered interest parity, comparing $\left(i_{t,k} - i^{*f}_{t,k}\right)$ with the forward discount. It is clear from (7) that nonzero onshore premia (due for example to existing or anticipated capital controls) and/or pure default premia (due to the differential default risk of local and foreign borrowers) will lead to the failure of broad covered interest parity, a result commonly found in studies using emerging market data.

In contrast, the "strict" version of the covered interest parity condition states that

$$\left(i_{t,k} - i^{*}_{t,k}\right) = fd_{t,k}. \qquad (10)$$

In this version, the assets involved differ only in their currency of denomination but not in their issuer.

Although empirical tests of the "strict" version of covered interest parity are hard to find in the literature, in principle one would expect it to hold up more generally than the broad version. But in practice several factors can cause even the strict parity condition to fail. First, default risk may differ across instruments issued in alternative currencies, even when issued by the same borrower in the same jurisdiction. This might reflect, for example, a threat of mandatory re-denomination of foreign-currency assets into local currency assets (akin to partial confiscation in the case of a devaluation), or also the fact that the government can print only local currency, so that it can redeem its local-currency obligations more easily than its foreign currency ones (or those of any debtor in need of bailout). In these circumstances, observed asset yields do not equal anticipated ones, and strict covered interest parity can fail to hold.

A second factor that can potentially affect the strict version of covered interest parity is transaction costs. Aside from default risk, arbitrage across onshore instruments in different currencies might involve potentially large costs resulting from various market imperfections – such as the impossibility of shorting certain assets, or the presence of large bid-ask spreads reflecting market illiquidity. This can also lead to a failure of the strict version of covered interest parity.[7] In such case, deviations from strict covered interest parity would be bounded by the magnitude of transaction costs. In the appendix we provide a more detailed analytical and empirical discussion of these issues.

We conclude this section with a final point on the exchange rate risk premium. Ignoring for the moment default risk and transaction costs – so that strict covered parity holds -- equations (7) and (10) together imply that the exchange risk premium equals the difference between the forward premium and anticipated depreciation:

$$errp_{t,k} = \left(fd_{t,k} - \Delta s^{e}_{t,k}\right). \qquad (11)$$

The patterns and determinants of the exchange risk premium have received considerable attention in the literature (e.g., Engel 1992, 1996; Lewis 1995). In a context of intertemporally-optimizing investors, it can be shown that the risk premium arises from the covariance between exchange rates and real consumption when investors are risk averse.[8] The premium can be positive or negative, which roughly speaking can be viewed as reflecting whether the domestic currency is perceived as more or less risky than the foreign currency, respectively. Several papers have explored how the magnitude of the risk premium is affected by investors' preferences towards risk. On analytical grounds the result is ambiguous, and depends on the specifics of the model at hand (see Engel

[7] A considerable literature has explored how various forms of transaction costs may lead to market segmentation and impact on covered interest arbitrage; see for example Blenman (1991).

[8] See for example Obsfeld and Rogoff (1998) and Engel (1999). More precisely, the exchange risk premium, typically measured as $E_t[S_{t+1} - F_{t+1}]/ S_t$ (the "nominal premium") or as $E_t[(S_{t+1} - F_{t+1})/P_{t+1}]$ / S_t (the "real premium", see e.g., Hakkio and Siebert 1995) generally involves two terms: one that depends on the degree of investors' risk aversion and the covariance mentioned in the text (which can be interpreted as the risk premium proper), plus another term reflecting nonlinearity of the premium in its defining variables. The latter term is independent of risk preferences and is generally presumed to be small in magnitude.

1999). Numerical simulations find more often than not that higher degrees of risk aversion lead to larger (in absolute terms) risk premia.[9]

II.d The term structure of currency premia

Finally, we consider briefly the term structure of currency premia (obviously, similar considerations can be made for country premia, but we will not pursue them here). For two different maturities k and k' we can write from (10) and (11) above

$$\left(i_{t,k}-i^{*}_{t,k}\right)-\left(i_{t,k'}-i^{*}_{t,k'}\right)= fd_{t,k}-fd_{t,k'}=\left(\Delta s^{e}_{t,k}-\Delta s^{e}_{t,k'}\right)+\left(errp_{t,k}-errp_{t,k'}\right) \quad (12)$$

This equation characterizes the term structure of currency premia. It reflects both the time path of anticipated depreciation and the term structure of the exchange risk premia. The literature has focused mostly on the former. Expected depreciation can be further decomposed into the perceived probability of devaluation and the magnitude of the devaluation, conditional on devaluation taking place. The time paths of these two factors shape the term structure of anticipated depreciation and thereby the term structure of currency premia.

Alternative trajectories of the subjective probability and the conditional magnitude of devaluation can result in very different term structures. In particular, the term structure can become inverted if the bulk of anticipated depreciation is concentrated in the near rather than the distant future.[10] This may happen, for example, when there is a

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[9] See for example Hakkio and Siebert (1995), Siebert (1996), and Evans and Kenc (2001). The latter authors also find that the risk premium is relatively insensitive to changes in the pattern of correlations among the forcing variables in their model.

[10] As an example, consider a fixed exchange rate regime where at time t the (log) exchange rate is s_0, and devaluation can happen at some uncertain future time τ. Let $s_{t+k}>s_0$ denote the exchange rate holding at time $t+k$ if devaluation has already happened (otherwise the exchange rate stays unchanged at s_0).

perceived probability of collapse of a fixed exchange rate regime, and the exchange rate after the collapse is expected to overshoot – so that the magnitude of the conditional depreciation is larger in the short than in the long run. Overshooting aside, term structure inversion is also more likely if agents expect devaluation to take place in the near rather than the long term – e.g., they expect either an immediate devaluation or no devaluation at all.

Along these lines, there is some literature that attempts to identify the likely term structure of expected depreciation under alternative currency regimes. For example, Favero, Giavazzi, and Spaventa (1997) argue that under floating exchange rates the term structure of anticipated depreciation tends to be flatter (even inverted) than under pegged rates, as in the former regime the bulk of depreciation may be projected to occur in the near future, while in the latter a plausible scenario may be an eventual abandonment of the peg, along with a cumulative devaluation.

Let $P[\tau > u]$ denote the subjective probability that devaluation will not happen prior to time u. The term structure of anticipated depreciation between $t+k$ and $t+k+j$ is:

$$\frac{1}{k+j}E_t[s_{t+k+j}-s_0]-\frac{1}{k}E_t[s_{t+k}-s_0]=\frac{1}{k+j}P[\tau\leq t+k+j][s_{t+k+j}-s_0]-\frac{1}{k}P[\tau\leq t+k][s_{t+k}-s_0].$$

After some manipulation, this can be rewritten as:

$$\frac{1}{k+j}P[t+k<\tau\leq t+k+j](s_{t+k+j}-s_0) \quad + \quad \frac{j}{k+j}P[\tau\leq t+k]\left[\frac{s_{t+k+j}-s_{t+k}}{j}-\frac{s_{t+k}-s_0}{k}\right].$$

The first part of this expression reflects the possibility of devaluation happening between t and $t+k$ – i.e., beyond the short run. It is non-negative and contributes to an upward-sloping term structure. The second part of the expression reflects the possibility of devaluation happening in the short term –i.e, prior to $t+k$. It is proportional to the difference in the *rates* of depreciation between t and $t+k$ and between $t+k$ and $t+k+j$. Its sign is ambiguous and depends on the anticipated path of the exchange rate when devaluation has happened. If the path involves a constant rate of depreciation, then the expression equals zero (the same happens if no devaluation can occur prior to $t+k$). If a step devaluation is anticipated (i.e., $s_{t+k} = s_{t+k+j}$) or, more generally, if a decelerating rate of depreciation is expected (such as in the case of exchange rate overshooting), the expression is negative.

III. Institutional features and empirical regularities

We next document the empirical regularities of the currency premium under two currency boards, Argentina and Hong Kong. We use daily data obtained from Bloomberg, the Central Bank of Argentina, Deutsche Bank, and the Hong Kong Monetary Authority. The data set contains rates from different markets and instruments (money market rates, interbank rates, and non-deliverable forwards), different currencies (Argentine pesos, Hong Kong dollars, and U.S. dollars), and different maturities (typically 1-, 3-, 6-, and 12-month). See Appendix Table 3 for a thorough description. This data set allows us to construct different measures of the premium for each of the two currency boards.

Since we will be working with premia embedded in forward contracts, we begin by describing the institutional characteristics of forward markets, which are not widely known. Next, we present an overview of the evolution of the currency risk premium under the two currency boards, going as far into the past as the data permit, and relating the observed developments in the premium with major local and global events. To do this, for each of the two countries we use the measure of the currency premium offering the longest time coverage. We then discuss the different measures of the currency premium available from the data and compare their behavior. Finally, we characterize the term structure of the currency premium.

III.a The forward exchange market [11]

There are different instruments traded in the foreign exchange market. The main ones are spot exchange contracts, forward contracts, and foreign exchange swaps. Related instruments like cross-currency interest rate swaps and foreign exchange options are traded in the interest rate derivatives markets.

Forward contracts are derivatives designed to hedge foreign currency exposure. There are two types of forward contracts. Foreign exchange forwards (outright forwards) are currency trades to be settled at an agreed time in the future. These contracts are also called deliverable forwards. Non-deliverable forwards (NDFs) are forward transactions whose settlement is made by a cash payment in U.S. dollars reflecting the market value of the contract, so that no local currency changes hands. Similar contracts used for major currencies are the so-called "foreign exchange transactions that settle in difference" (FXDS). NDF contract are mostly used for emerging market currencies; they involve smaller volume trades and longer dated maturities.

NDFs are used as a means to scale back foreign exchange settlement risk. This risk arises because in foreign exchange transactions currency may need to be paid out by one party before the other currency is received, making the first party vulnerable to the risk that the second party does not fulfill its obligation. Other advantages of these contracts over deliverable contracts include lower transactions costs, a reduced role for credit limits, and greater liquidity. With no principal to exchange and no principal at risk, credit limits are less important and liquidity is enhanced.

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[11] For more information on these markets, see Federal Reserve Bank of New York (2001) and the Trade Association for Emerging Markets at www.emta.org. We especially thank Starla Cohen from EMTA for sharing data with us.

Even though NDFs present fewer risks than deliverable forwards, they do still pose some risk. The primarily concern is "fixing risk," namely whether it will be possible to calculate the exchange rate in order to value the contract and determine the dollar settlement amount. For certain currencies, this risk is considered more manageable than the risks associated with deliverable contracts, since the currency at issue might become subject to restrictions, making it impossible to transfer the currency to the counterparty.[12] (A previous problem was related to the documentation of these trades, causing many transactions not to be properly confirmed. This problem has now been addressed.)

NDFs are traded mostly in New York for Latin American currencies. Russian, Central and Eastern European currencies trade out of London. The market for Asian currencies trades out of Hong Kong, Singapore, and Tokyo, with Singapore being the most significant market. The banks that participate in this market are large international banks. They include ABN AMRO, AIG, Bank of America, Deutsche Bank, Fleet Bank, Goldman Sachs, HSBC, ING-Barings, JP Morgan Chase, Merril Lynch, Morgan Stanley, Standard Chartered, and UBS. There are approximately 40 institutions in the Emerging Markets Traders Association (EMTA) NDF working group; approximately 20 institutions participate regularly in the working group meetings. Most trades are believed to take place between dealers offshore. Most of the inter-dealer activity, however, involves hedging underlying contracts with clients.

The most important NDF currencies are the Argentinean peso, the Brazilian real, the five major currencies in Asia (the Chinese renminbi, the Indian rupee, the Korean won, the Philippine peso, the Taiwan dollar), and the Hungarian forint. Activity in

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[12] Another problem – now settled – with NDF contracts related to the incomplete documentation of the trades, which caused many transactions not to be properly confirmed.

Russian ruble is very slight at present. There is also some trading activity in the Chilean peso and the Peruvian sol. Possibly developing into NDF markets are also the Indonesian rupiah and the Thai baht.

Volume information on NDF transactions is limited, because the corresponding data is not publicly available and because market participants do not necessarily mark their deliverable and NDF transactions separately. As part of the triennial central bank survey of foreign exchange and derivatives market activity prepared by the Bank for International Settlements, the Federal Reserve Bank of New York (2001) recently collected some statistics on the turnover of forward contracts (including deliverable and non-deliverable forwards) in the U.S. during April 2001. From this survey, one can conclude that forward markets are large when compared with spot markets. In the overall U.S. market, forward contracts represent about one third of the spot foreign exchange market. Turnover in the U.S. spot market was $1.8 trillion while that of the forward market was $640 billion during April 2001. But when looking beyond the major six currencies (euro, Japanese yen, British pound, Swiss franc, Canadian dollar, and Australian dollar) against the U.S. dollar, forward markets become even more important. They are almost as large as spot markets. Turnover in the spot market was around $129 billion, compared with $114 billion in the forward markets during the month of the survey. When looking at individual currencies, including a number of emerging market currencies, a similar relation holds. For example, in the case of Hong Kong, turnover was $10.8 billion in the spot market and $8 billion in the forward market. Although the NDF market for the Argentine peso is one of the largest, the report does not provide specific data.

III.b The currency premium: evolution over time

The case of Argentina[13]

On April 1, 1990, the Convertibility Law established the unrestricted convertibility of the peso into U.S. dollars at a fixed rate of 1 to 1 for both current and capital account transactions. The convertibility of the peso and its parity are defined by law; any modifications must be approved by Congress. The law requires the central bank to hold an amount of dollars equal to the entire monetary base at all times, although a limited proportion of this backing can be held in domestic government bonds. For this reason, some argue that the Argentine scheme is not a currency board in a strict sense.

The currency board in Argentina offers a fruitful ground to study the behavior of the currency premium. Figure 1 and Table 1 display the time pattern of the currency premium, measured by the difference between the 1-month peso and dollar local deposit rates (in annual terms), and its summary statistics. We use deposit rates, which are generally less sensitive than other rates to the different political and economic events.

Table 1 shows that in Argentina the currency premium remained positive throughout the period for which data is available, although in general its magnitude was modest – the sample mean equals 189 basis points. However, the premium varied significantly over time, reflecting major domestic and international events that impacted on actual and anticipated monetary and financial conditions in Argentina. During these "crisis" episodes the average currency premium was 382 basis points, while during the

[13] We collected the events in Argentina from Ganapolsky and Schmukler (2001), who provide a detailed description of the 1995 crisis management in Argentina. We also collected news from two local newspapers, Clarín and La Nación, available online at www.clarin.com and www.lanacion.com.

"tranquil" periods after the Mexican crisis the average currency premium was 124. We next review briefly the main discrete events affecting the Argentine currency premium.

The Mexican crisis that started in December 1994 had strong spillover effects on Argentina. The Argentine peso came under attack and there was a run on bank deposits. A number of measures were taken to avert the collapse of the currency board, but markets recovered only after Mexico and Argentina signed an agreement with the International Monetary Fund (IMF) in March 1995. During the Mexican crisis period the average currency premium was 578 basis points, well above the average 242 basis points registered in October 1994 and the 163 in August 1995.

On May 15, 1995, former president Menem was reelected. His relation with the then economy minister Cavallo (the architect of the Convertibility Law) deteriorated and on July 26, 1996 Cavallo was replaced by central bank president Roque Fernandez. This triggered an increase of the currency premium to 158 basis points, from 85 in the previous month. In October 1997, Argentina was hit by the Asian crisis, in particular by the attack on the Hong Kong currency board. The currency premium hit 393 basis points on November 6. Then the Russian devaluation and default on August 18, 1998 also impacted Argentina, as well as other markets around the world. The currency premium jumped to 405 basis points on September 15. Argentina was also hit by the devaluation of the Brazilian real on January 13, 1999, with the currency premium rising to an average of 210 basis points in the aftermath of this event. The then former minister Cavallo declared to the Financial Times newspaper on May 17, 1999 that Argentina could eventually float its currency while maintaining the convertibility program. The markets reacted with an increase in the currency premium to 185 basis points on June 1. The currency premium continued climbing due to the political uncertainty surrounding the upcoming presidential election.

On October 23, 1999, De la Rua was elected as the new president of Argentina. The currency premium continued increasing but declined significantly in January 2001. Almost one year after taking his post, vice president Carlos Alvarez resigned on October 6, 2000, due to disagreements with the president upon how to resolve an existing bribery scandal in the Senate. This generated a political crisis in the government alliance, and the currency premium rose to an average of 216 basis points in the aftermath of the resignation. The political and economic situation stabilized until economy minister Machinea resigned on March 2, 2001, after agreeing to a 40 billion package with the international community on December 2000.

On March 19, two weeks after the resignation of economy minister Machinea, the newly appointed economy minister Lopez Murphy resigned as well, upon strong opposition to the new package he had sent to Congress on March 16. The currency premium rose sharply on March 16 to 387 basis points. Cavallo assumed once more as economy minister and, on April 16, he sent to Congress a proposed amendment to the Convertibility Law, according to which the peso would be pegged to a basket consisting of U.S. dollars and euros with equal weights.[14] On April 20, after a week in which the government had actively promoted the newly proposed currency board, former president Menem advised citizens to convert their pesos into U.S. dollars, arguing that the proposed law entailed a devaluation of the peso. The currency premium peaked again, hitting 1,100 basis points. On the whole, over the two-month period following the change in economy

[14] Congress approved the law in mid June.

ministers the currency premium averaged 548 basis points. The last crisis in the sample starts on July 10, 2001, when the government was forced to pay an interest rate of 1,410 basis points at the time it issued a short-term bond. Both market participants and the government considered at that time that it was not longer possible to continue accessing capital markets at sustainable rates. The government decided to stop tapping capital markets and to reduce expenditures to eliminate the financing gap. When this cut of international credit became obvious, the currency premium rose to 1,986 basis points on July 13 and remained high thereafter at an average over 1,000 basis points.

To give a rough idea of the economic dimension of these premia, assume for a moment that uncovered interest parity holds (as in equation (4) above). The observed interest differential then provides a direct measure of devaluation expectations, and we can compute the magnitude of the anticipated depreciation consistent with the data for various subjective probabilities of devaluation. Specifically, we consider 10, 25, 50, 75, and 90 percent probability of devaluation over the coming month. Table 2 displays the implied devaluation magnitudes, distinguishing between tranquil and crisis periods. We use the maximum value reached by the currency premium during each period to obtain the maximum expected devaluation. The table shows that during tranquil periods a premium of 812 basis points on a 1-month deposit annualized rate corresponds to an expected devaluation of 8,122 (902) basis points for a 10 (90) percent probability of devaluation. At the other extreme, when Argentina suffered the cut of international credit, the expected devaluation jumped to 19,861 (2,207) basis points under an expected probability of devaluation of 10 (90) percent. Though these magnitudes are already large, from the discussion below it will become apparent that similar calculations applied to the NDF currency premium would yield a much larger anticipated devaluation.

The case of Hong Kong[15]

The currency board in Hong Kong also offers an interesting case study of the currency premium. In this case, we use the currency premium implied from deliverable forwards. The premium and the corresponding summary statistics for the 1-month maturity (in annual terms) are also reported in Figure 1 and Table 1.

The Hong Kong currency board was established in October 1983. The Hong Kong dollar is pegged to the U.S. dollar 7.80 to 1, but in September 1998 the rate changed to 7.75 to 1. Between April 1999 and August 2000 the exchange rate moved gradually from 7.75 back to 7.80. Since 1983 the Hong Kong dollar has been freely convertible. The Hong Kong Monetary Authority is responsible for keeping the peg.

Table 1 shows that, unlike in Argentina, the currency premium was at times negative (although of small magnitude) in Hong-Kong. Its sample mean is close to zero in tranquil times, and equal to 301 basis points in turbulent times. Another difference with Argentina is that there are fewer identifiable events, and instead there is a prolonged period of turbulence surrounding the East Asian crisis.

Although not very large, the Mexican crisis had some spillover effects on East Asia, where it put pressure on strong currencies. On January 12, 1995, the currency premium in Hong Kong jumped to 193 basis points from 63, and hit 340 on January 23.

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[15] We collected the events in Hong Kong from Bloomberg, the Financial Times, and Nouriel Roubini's website, www.stern.nyu.edu/globalmacro/AsiaChronology1.html, and Cheng, Kwan, and Lui (1999b).

But the impact of the East Asia crisis was much stronger. On January 27, 1997, after the collapse of a large South Korean chaebol and signs of financial distress, Hong Kong decided to take part in an International Monetary Fund scheme to help countries threatened with financial or economic crises and to secure its position as an international financial center. The following day, the currency premium jumped from –19 to 375 basis points. On May 14 and 15, 1997, the Thai baht was hit by a speculative attack. Some governments intervened in the foreign exchange markets and even introduced selective capital controls. The Hong Kong currency premium jumped from 83 to 288 basis points on May 19 and then to 621 on June 15, as the financial situation deteriorated in Thailand. On July 2, 1997, Thailand was forced to float the baht, and the crisis spread to other countries.

During the East Asian crisis the Hong Kong dollar suffered four major attacks. The first attack started on August 15. The currency premium increased from 178 to 826 basis points on that day and further to 1,157 basis points on August 18. The attack on the Hong Kong dollar peaked the week of October 20, after the devaluation of the Taiwan dollar the previous week. The currency premium hit its all-time high of 2,840 basis points on October 23. The attack on the Hong Kong dollar was different from the typical currency attack because speculators were shortening both stocks and the currency. Investors borrowed equities in Hong Kong dollars and held long position on U.S. dollars. Due to the currency board constraints, the interest rate rose to compensate the reserve outflow, further depressing equity prices. To stop speculation, the monetary authority intervened in the equity market buying stocks and futures.[16]

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[16] See Chakravorti and Lall (2000) for an explanation of this simultaneous attack.

In early 1998, the crisis continued deepening as several currencies in the region – including those of Indonesia, Malaysia, Thailand, and the Philippines – reached historic lows relative to the U.S. dollar. The currency premium went from 366 to 849 on January 7 and 1,165 on January 12, when the Hong Kong dollar suffered the second major attack during January 12-20. Markets throughout the Pacific Rim hit another low on June 10, with worries spreading to Japan. The third major attack on the Hong Kong dollar followed in June 11-19. The currency premium increased again that day to 664 from 325, jumping to 1,119 on June 15. On August 5, when Chinese officials threatened to devalue the yuan if the yen kept falling, the Hong Kong currency risk jumped to 664. The fourth attack took place between August 26 and September 2, with the Hong Kong dollar reaching 1,309 on August 28 after the Russian default. The mean currency premium during the attacks is much higher than the one during tranquil periods, reaching values between 386 and 598 basis points. On September 13, the chief executive of the Hong Kong Monetary Authority acknowledged a possible change in the peg from 7.75 to 7.8, what prompted an increase in the currency premium. Markets started to calm down on September 16, when the Hong Kong Monetary Authority announced that the parity would not change for six months and that it would then adjust gradually over a period of 500 working days.

Table 2 shows also for the case of Hong Kong the magnitude of the expected devaluation implied by alternative probabilities of devaluation. Again, these scenarios include a 10, 25, 50, 75, and 90 percent probability of devaluation. Compared with the deposit rate estimates from Argentina, the magnitude of the expected devaluation is much smaller in Hong Kong. During tranquil times, the expected devaluation ranges from

3,252 to 361 basis points when considering a 10 and 90 percent probability of devaluation. At the other extreme, during the first attack on the Hong Kong dollar expected devaluation ranged between 28,398 and 3,155 basis points. This corresponds to a currency premium of 2,840 basis points.

III.c Alternative measures of the currency premium

In this section, we compare alternative measures of the currency premium. In Argentina, interest rates on different types of loans and deposits are quoted both in pesos and U.S. dollars. Domestic and large international banks participate in the local financial market. The differentials between dollar and peso interest rates on these instruments provide measures of the currency premium derived from the money market. In addition, the forward discount implied by NDFs provides another measure of currency premium. In the case of Hong Kong, deliverable forward contracts are also available. But to construct the currency premium from intebank rates, we need to use the total interest rate differential, namely the difference between the Hong Kong interbank offer rate (HIBOR) and the London interbank offer rate (LIBOR). This is the same measure used by Cheng, Kwan, and Lui, (1999a). As noted in Section II, this measure contains not only the currency premium but also the country premium, which is commonly assumed to be very small in the case of Hong Kong.

The different measures of the currency premium implied by the various assets are displayed in Figure 2, while Table 3 presents their summary statistics for the 1-month maturity over the sample for which all measures are available. Figure 2 shows that the different premia move generally together. For example, Table 3 shows that the correlation among the various Argentine instruments ranges between 0.78 and 0.91. In the case of Hong Kong, the correlation between the two available rates is 0.94. However, even though the different measures of currency premia display strong comovement there are visible differences across instruments and maturities. Table 3 shows that the currency premium implied by the forward market tends to be higher than the various measures of money market premia. In Argentina, for the whole sample, the (annualized) average premium from the NDFs exceeds 800 basis points, while the average premia derived from the money market is between 206 and 318 basis points. This reflects in part a few large spikes in the forward discount, whose mean is considerably above the median. Among the money market measures, only the currency premium implied by lending rates shows spikes of comparable magnitude. In the case of Hong Kong, the average forward discount is 58 basis points, while the average difference between local interbank rates and LIBOR rates is 39, despite the fact that the latter should contain the country risk premium in addition to the currency premium.

III.d Term structure of currency risk premia

Comparison of the currency premia at different maturities can reveal information on market perceptions regarding the likelihood, anticipated magnitude and riskiness of exchange rate changes at different horizons, as well as show how those perceptions are affected by domestic and external developments.

We focus on the term premium between long and short maturities, defined as the differential between the 12-month and the 1-month currency premia.[17] Figure 3 portrays

[17] This is the same approach used by Domowitz, Glen, and Madhavan (1998) to analyze the term structure of the country and currency premium in Mexico prior to the Tequila crisis.

the term premium for Argentina and Hong Kong, while Table 4 presents the corresponding descriptive statistics. We present two term premia, one derived from the forward market, and another from the interbank market.[18]

Figure 3 illustrates how the term premium reacts to relevant events to the economies. In the case of Argentina, the "yield curve" of the currency premium appears to have become steeper after the Brazilian crisis, up to the final portion of the sample corresponding to the resignation of the economy ministers, when the yield curve becomes sharply inverted. Thus, except for the final part of the sample, this suggests that devaluation of the real raised expectations of *eventual*, more than *immediate*, devaluation of the peso. A similar effect appears to have arisen from the 1999 Financial Times article mentioned above, in which Cavallo first advanced the idea of modifying the currency board. Figure 3 shows that the term premium increased; in fact, the 1-month currency premium was flat, while it rose at longer maturities. In other words, markets perceived that no change was likely in the immediate future, but there was increased uncertainty about future changes after the upcoming presidential election. The term premium becomes negative at times, in particular during the Asian crisis, Russia's default, and most notably in the 2001 crisis.

In Hong Kong, the term premium is close to zero during most of the sample. But the term premium turns slightly negative during the Mexican crisis and the early signs of distress in South Korea. The term turns sharply negative at the peak of the different attacks on the Hong Kong dollar. The term premium increased significantly right after the first attack on the Hong Kong dollar and only converged to close to zero in late 1999.

[18] As before, in the case of Hong Kong the latter measure is based on the difference between onshore Hong Kong dollar deposit rates and U.S. dollar deposits in the U.S., so it may include a country premium.

This evidence suggests that investors revised their expectations about the sustainability of the currency board during the crisis, becoming somewhat pessimistic about the future of the peg in the long run after the Hong Kong dollar was heavily attacked. In the midst of the financial stress they were more concerned about the short-tem prospects.

Table 4 displays summary statistics of the term premia for Argentina and Hong Kong. The table shows that on average the term premium is positive. It is also larger for Argentina than for Hong Kong, suggesting that markets are more uncertain about the long-run viability of Argentina's peg than that of Hong Kong.

The table also shows that the term premium is typically larger in tranquil as opposed to turbulent periods. Indeed, at times of extreme turbulence – such as those corresponding to the economy minister resignations in 2001 in Argentina and the subsequent cut in international financing – the term premium becomes negative, particularly in the case of the Argentine NDF, for which the 1-month over 12-month differential reached a peak of 11,720 basis points. In the case of Hong Kong, the mean term premium is negative during the Mexican crisis and the beginning of the Asian crisis. The term premium reached large negative numbers during each of the different crisis episodes, hitting 1,854 basis points during the first attack on the Hong Kong dollar. The mean term premium is positive during the subsequent attacks because the negative values only last for a few days.

Market participants closely follow these inversions in the term premium. Investment banks tend to recommend trades according to the slope of the yield curve and their assessments of risks at different horizons.[19] This behavior of the term structure also echoes bond market evidence that the slope of the yield curve changes from positive to negative when markets perceive a higher default probability; see for example Gavin and Kulesz (2000).

IV. Determinants of the currency premium and its term structure

We turn to an empirical analysis of the determinants of the currency premium. Our objective is to identify the impact of economic variables as well as local and global events on the premium. Data constraints force us to limit the econometric analysis to Argentina. The primary reason is the unavailability of daily domestic financial data for Hong Kong with an adequate time coverage. Here we focus on the NDF-based premium measure. In the appendix below we examine in depth the observed differential between the NDF and the premium implied by interbank interest rates.

The starting point for the econometric analysis is equation (11) above, rearranged to read

$$fd_{t,k} = \left(\Delta s^{e}_{t,k} + errp_{t,k}\right). \qquad (13)$$

We can further decompose anticipated depreciation $\Delta s^{e}_{t,k}$ into the subjective probability held at time t of a depreciation happening prior to $t+k$, that we denote $P_{t,k}$, and the magnitude of the depreciation, that we denote by $(s_{t,k} - s_t)$. With probability $1 - P_{t,k}$ the exchange rate stays unchanged at its current level s_t through time $t+k$. $s_{t,k}$ is the log of

[19] For example, one can find in major financial newsletters many phrases like "The NDF yield curve has flattened again. We see these periodic inversions as opportunities to add to long peso positions in the short end."

the spot exchange rate expected to prevail at time $t+k$ if a devaluation should occur between times t and $t+k$. Thus from (13) we have:

$$fd_{t,k} = P_{t,k}\left(s_{t,k} - s_t\right) + errp_{t,k}. \quad (14)$$

The next step is to relate the anticipated magnitude of the depreciation, the subjective devaluation probability, and the risk premium to observable counterparts. Starting with the first of these, the most common approach in the literature is to relate the anticipated devaluation to some measure of real misalignment of the currency, typically summarized by the departure of the real exchange rate from some equilibrium value. However, we will be working with daily data, and no information on prices or real variables exists at such frequency. Since we will be using a relatively short period, it might be reasonable to assume that there is little variation in the magnitude of the peso's perceived real misalignment over the sample period, beyond what can be captured by a time trend. Thus, we include a linear trend in our basic specification. Nevertheless, we also experiment with a proxy for real exchange rate misalignment available from Goldman Sachs, which is constructed on the basis of lower-frequency real and financial data and then interpolated to yield daily observations.[20] Finally, we also allow an impact of the Brazilian devaluation of 1999 on the perceived degree of peso misalignment, by adding a dummy variable (see below).

As for the subjective probability of devaluation, we assume that it is inversely related to the stock of international reserves relative to total bank deposits, which

[20] To construct a measure of the foreign exchange misalignment, Goldman Sachs uses deviations of an estimated equilibrium exchange rate (called GSDEEMER) from observed trade-weighted real exchange rates. To obtain the equilibrium exchange rate, Goldman Sachs uses various economic fundamentals such as terms of trade, government consumption, total factor productivity, and capital flows, among others. See Goldman Sachs (1999).

provides a measure of the ability of the currency board to deter a run on the Argentine peso or on the banking system. Thus, this variable is a proxy for the sustainability of the convertibility system. Furthermore, we are interested in assessing the role of foreign reserves taking the form of hard-currency assets vis-à-vis those in the form of public sector debt, which are also permitted by Argentina's regulations but are viewed with some suspicion by international investors. Hence we also present regressions allowing these two components of reserves to carry different coefficients.

To capture the risk premium component of (14), we use measures that reflect markets' perceptions about risk.[21] The first one is the EMBI spread for Latin American debt (excluding Argentina's), which we take as a measure of the perceived riskiness of Latin American assets in general. The second is the premium on U.S. high-yield assets, which we take as a measure of international investors' overall "appetite for risk." In our basic specification, these two variables capture the risk perceptions of international investors. In addition, we also present some experiments adding in the regression the risk rating of Argentine foreign currency debt as determined by major international risk-rating agencies.[22]

To these proxies for international investors' risk perceptions, we also add in our basic specification the liquidity position of Argentine banks, as reflected in the ratio of their cash reserves to total deposits, that we take as a summary measure of banks' attitude towards risk. An increase in financial volatility (i.e., the risk perceived by banks) or an

[21] This is in the spirit of Lewis (1995).

[22] Specifically, we use the average of the risk ratings of the three leading agencies: Moody's, Standard and Poor's, and Fitch-IBCA. We assign numerical values to the various risk categories considered by each agency, and average them over their respective ratings for Argentina's sovereign foreign-currency debt.

increase in their risk aversion should be reflected in the banks' decision to maintain higher liquidity ratios.

It is important to emphasize that, as already stated, the literature offers no definite prediction regarding the sign of the impact of these risk preference proxies on the exchange risk premium. However, simulation exercises tend to suggest that higher risk aversion increases the absolute magnitude of the premium.[23] Thus, one might expect that if the peso is regarded as riskier than the U.S. dollar (so that the risk premium is positive) then higher risk aversion would yield a larger risk premium and, other things equal, a larger currency premium, so that the risk aversion proxies just listed would carry positive coefficients in the regression.

This argument, however, is subject to two caveats in the case of the U.S. high-yield spread, which may capture other forces at play, in addition to investors' overall risk appetite. The first caveat arises from the fact that the perceived riskiness of U.S. junk and Argentine assets may move in different directions, reflecting investors' substitution among alternative assets. For example, a shift out of U.S. high-yield assets and into emerging-market (including Argentine) assets could result in an a higher premium for the former but lower for the latter. The second caveat concerns the role of the high-yield spread as a predictor of the U.S. business cycle. As has been amply documented, a higher spread indicates the anticipation of a growth slowdown in the U.S., and conversely for a lower spread. To the extent that the U.S. dollar tends to appreciate in booms and depreciate in slowdowns, an increase in the U.S. high-yield spread could signal an impending depreciation of the dollar vis-à-vis other currencies, and thereby an anticipated

[23] See for example Evans and Kenc (2001).

reduction in the degree of overvaluation of the Argentina peso in trade-weighted terms, which *ceteris paribus* would tend to reduce the forward discount on the peso. Conversely, a reduction in the high-yield spread would imply larger peso overvaluation in the future and thereby lead to a larger forward discount. Through this channel, changes in the high-yield spread could cause changes in the forward discount in the opposite direction.

Finally, we also estimate additional specifications including dummy variables to control for the effects of the domestic and foreign political and economic events summarized in Section III. To limit the number of dummy variables, we combine the two external shocks in our sample (the periods of Russian crisis and the devaluation of the Brazilian real identified in Table 2) into a single "external shock" dummy, and likewise combine the various domestic crises episodes in Table 2 into a single "internal shock" dummy.

Some considerations regarding econometric technique are necessary. Regarding the time-series properties of the data, preliminary augmented Dickey-Fuller (ADF) tests of unit roots yielded mixed results. Forward premia were found to be I(0) – in agreement with the results of, e.g., Clarida and Taylor (1993) – while for other variables the results varied depending on sample size and lag length. This is unsurprising given the short-time coverage of our sample, which surely results in very low power of the tests and makes them rather uninformative. Since our regressors are basically interest rate spreads and financial ratios, we follow the views expressed by Cochrane (1991) and proceed under the assumption that they are all stationary.

A second consideration regards the potential endogeneity of the right-hand side variables. The domestic financial ratios (the central bank's foreign assets and banks' cash reserves relative to deposits) are publicly announced with a 3-day delay; hence we take these variables as predetermined. Next, we take the high-yield spread to be exogenous. Finally, the Latin American EMBI spread that we use refers to region-wide assets excluding Argentina,[24] and as a working hypothesis we shall assume it exogenous as well.[25]

The third issue refers to dynamics. To allow for some degree of persistence, we use a dynamic specification including lags of the dependent and independent variables. Our starting point follows along the lines of Hendry's GUM (general unrestricted model) specification:

$$y_t = c_0 + \sum_{j=1}^{k}\sum_{\tau=0}^{q} b_{j\tau} x_{j,t-\tau} + \sum_{i=1}^{p} a_i y_{t-i} + u_t \,. \qquad (15)$$

This is just an unrestricted autoregressive-distributed lag (ARDL) model of order (p, q). With some straightforward manipulations, it can be rewritten as

$$\Delta y_t = \sum_{j=1}^{k}\sum_{\tau=0}^{q-1} B_{j\tau} \Delta x_{j,t-\tau} + \sum_{i=1}^{p-1} A_i \Delta y_{t-i} + \left[c_0 + \alpha_1 y_{t-1} + \sum_{j=1}^{k} \beta_j x_{j,t-1} \right] + u_t \,. \qquad (16)$$

The term in square brackets in the right-hand side of (16) captures the "long-run" version of (15). Here $\alpha_1 = \left(\sum_{i=1}^{p} a_i \right) - 1$ and $\beta_j = \sum_{\tau=1}^{q} b_{j\tau}$ are the sums of coefficients on the dependent and independent variables, respectively. The long-run impact of regressor j on y can be found as $-\frac{\beta_j}{\alpha_1}$.

[24] Specifically, it is a weighted average of the EMBIs from individual Latin American countries excluding Argentina, with 1999 GDP weights.

[25] We are well aware that developments regarding the perceived solvency of Argentina might impact on that of other countries in the region. However, we presume this effect to be smaller than the one operating in the opposite direction, namely the impact of the region as a whole on Argentina.

In the empirical implementation, we estimate (16) by OLS setting $p=q=4$, i.e., including four lags of the dependent and independent variables (beginning with lag 3 in the case of the domestic financial ratios). To save space in the tables below we only report the long-run coefficients α_1 and β_j and omit the dynamics.

To complement these OLS regressions, we also perform additional estimations allowing for conditionally heteroskedastic disturbances, which are fairly common in high-frequency financial data such as ours. Indeed, Tables 1 and 4 above clearly suggest that volatility of the premium and its term structure change over time, becoming noticeably higher at times of internal and external crises. While OLS estimates of equation (16) remain consistent in the presence of heteroskedasticity, and our inferences are based on robust covariance matrix estimates, efficiency gains are possible by explicitly modeling heteroskedasticity. In particular, we use the exponential GARCH (EGARCH) specification of Nelson (1991), which can be written as

$$\log\sigma_t^2 = \pi_0 + \sum_{j=1}^{N}\pi_{1,j}\log\sigma_{t-j}^2 + \sum_{j=1}^{M}\pi_{2,j}\left\{|v_{t-j}| - E|v_{t-j}|\right\} + \sum_{j=1}^{M}\pi_{3,j}v_{t-j} \qquad (17)$$

where $v_t = \frac{u_t}{\sigma_t}$. In the estimations reported below we use $N=M=1$. Compared with standard GARCH, this specification offers the added flexibility of allowing asymmetric effects on volatility of positive and negative disturbances (which arise when the $\pi_{3,j}$ are not zero), a feature that has proven useful in modeling financial asset prices (e.g., Pagan and Schwert 1990). Moreover, the EGARCH model is computationally simpler than standard GARCH, which is a major concern given our relatively short sample and our specification with several regressors and multiple lags. Indeed, to achieve convergence of the EGARCH estimates we were forced to employ a somewhat shorter lag specification in order to preserve sample size. In particular, we omitted lags beyond the fourth one, so that for the domestic financial ratios (foreign reserves and bank liquidity), available with a three-day delay, we used only the third and fourth lag.

Table 5 reports regression results with the 1-month NDF premium as dependent variable. The first five columns report OLS estimates of equation (16), while the last two columns present EGARCH(1,1) estimates of (16) and (17). As already noted, to save space only the long-run coefficients of (16) appear in the table.

The first column presents the basic specification. As expected, we find that foreign reserves have a negative and significant effect on the premium. Among the risk proxies, the Latin EMBI spread carries a positive and significant coefficient, and the same applies to domestic banks' liquidity ratio. In turn, the U.S. high-yield spread has no significant effect, nor does the time trend intend to capture peso misalignment. The summary statistics at the bottom of the table show that the estimated equation has a high explanatory power, as reflected by an R-squared in excess of .40, which is rather satisfactory given that we are working with daily data. Finally, the Q statistics reveal no symptoms of autocorrelation.

Column 2 in Table 5 replaces the time trend with the Goldman Sachs misalignment proxy. This results in the loss of 20 observations for which the latter variable is not available. Its coefficient estimate carries a positive sign, as expected, but the precision of the estimate is very poor. The remaining estimates are qualitatively similar to those in the first column. In turn, column 3 breaks down foreign reserves into their hard-currency and public-debt components. We find that only hard-currency reserves have a significant negative impact on the forward premium; bond reserves carry a negative coefficient as well, but statistically not different from zero. The other parameters are very similar to those in column 1.

In column 4 we add to the regressors the risk rating of Argentine foreign currency debt, averaged over the three major rating services. As constructed, a higher value of the variable denotes a better rating (i.e., lower risk). Its coefficient estimate is negative and significant, as expected. Now, however, the coefficient on the foreign reserve/deposit ratio becomes much smaller and insignificant. This is very likely a reflection of the fact that rating agencies view foreign reserves as one (or the) key factor in their risk assessment. The remaining estimates are similar to those in the basic specification of column 1. Next, in column 5 we add the internal and external shock dummies. Both carry positive and significant (at the 10 percent level in the case of the external shock dummy) coefficients, which confirms the finding in Table 1 that the forward discount typically rises at times of turmoil. Interestingly, the coefficients on the Latin EMBI spread and the foreign reserve ratio show a considerable decline in magnitude relative to the basic specification, and the former becomes insignificant. This is a clear reflection of the fact that the Russia and Brazil shocks summarized in the "external shock" dummy are also reflected in major swings in the EMBI, while both internal and external shocks typically resulted in reserve losses. Hence the event dummies capture some of the explanatory power of these two economic variables.

In column 5 we are allowing for crises to affect the conditional mean of the forward premium but not its conditional variance. From Table 1, however, we know that the volatility of the premium is considerably larger at times of shocks. We allow for a time-varying conditional variance by introducing EGARCH effects in columns 6 and 7 of

Table 5. As already noted, we had to use a somewhat reduced dynamic specification to preserve sample size and achieve convergence of the estimation procedure. As a result, the sample underlying these estimates is larger than those used in the OLS regressions. In addition, we further simplified the specification in column 5 by combining the two shock dummies into a single "crisis dummy."

Column 6 presents an EGARCH(1,1) specification allowing for the effect of crises on the conditional mean of the premium. Qualitatively, the estimates are broadly similar to those in column 5, although their magnitudes change somewhat reflecting the change in sample. We continue to find significant positive effects on the premium of banks' liquidity ratio and the crisis dummy, and negative and significant effects of the foreign reserve ratio. The Latin EMBI spread remains insignificant like in column 5. Now, however, we also find a significant positive impact of the high-yield spread and the time trend that proxies for misalignment. The GARCH parameters are strongly significant as well, and in particular they suggest an asymmetric effect of disturbances on the conditional variance, with negative disturbances raising the conditional variance more than positive ones. The Box-Pierce statistics, however, suggest some mild evidence of residual autocorrelation.[26]

In column 7 we expand the EGARCH specification to allow also for an independent effect of crises on the conditional variance. We do this by adding the crisis dummy in the variance equation.[27] This causes some changes in the parameter estimates relative to those in the preceding column. In particular, the EMBI spread is now positive

[26] Note that the Q statistics in columns 6-7 refer to the "scaled" residuals denoted by v in equation (17).

[27] We thank Sebastian Edwards for making this suggestion. See Edwards and Susmel (2001) for a more sophisticated application of GARCH models with regime switches.

and significant, and the high-yield spread reverses sign – it now carries a negative and significant coefficient. Foreign reserves and banks' liquidity remain significant, although their parameters become much smaller than in the preceding column. The crisis dummy continues to have a significant positive impact on the premium and, in addition, now it is found to have a significant positive impact on the conditional variance as well. There continues to be strong evidence of EGARCH effects, but the estimates do not suggest any asymmetric effects of disturbances anymore. Finally, the Q statistics do not reveal any symptoms of autocorrelation.

Table 6 turns to estimation of the determinants of the NDF term premium, measured by the difference between the 12-month and 1-month premia. In addition to the explanatory variables in the preceding table, we introduce also the term premium of U.S. interest rates of similar maturity, to provide a benchmark for the term premium generally demanded by investors.

Like in the previous table, columns 1 to 5 reports OLS regressions, while columns 6-7 report EGARCH estimates, using the same array of specifications as before. Column 1 presents the basic specification. We find that the foreign reserves to deposits ratio exerts a significant positive effect on the term premium, suggesting that the announcement of higher reserves reduces more the short-term NDF premium than the longer-term one. This likely reflects the fact that higher reserves lower the perceived probability of *immediate* devaluation relative to the probability of *eventual* devaluation. On the other hand, the liquidity ratio of banks carries a negative sign, which suggests that banks' decision to hold larger cash reserves relates more to perceived short-term risks than long-term ones. The remaining coefficient estimates are insignificant. The explanatory power of the equation is quite high, as reflected by its R-squared of .46, and the residuals show no signs of serial correlation.

Column 2 uses the Goldman Sachs misalignment proxy. Like in the regressions of the 1-month premium, its coefficient estimate is positive but highly imprecise. Column 3 disaggregates foreign reserves into hard-currency and public-debt assets. Both carry significant positive coefficients, but that of bond reserves is much smaller and significant only at the 10 percent level. This suggests that the impact just described of foreign reserves on perceived devaluation probabilities at different horizons is mostly due to hard-currency reserves.

Column 4 adds to the basic specification the risk rating of foreign-currency Argentine debt. Like with the 1-month premium, the main consequence is to render foreign reserves insignificant, confirming the interpretation given earlier that risk ratings are strongly affected by foreign reserve holdings. Column 5 adds the internal and external shock dummies. Both carry significantly negative coefficients, in accordance with the fact noted earlier that the term structure tends to become inverted at times of crisis. Introducing the dummies also causes some changes in other parameters. Most notably, the high-yield spread becomes significant at the 10 percent level with a negative sign, while foreign reserves become insignificant.

Columns 6 and 7 report EGARCH estimates, restricting as before the lag length of the domestic financial ratios in the estimated specifications – in order to conserve sample size – and combining the two crisis dummies into a single one. In column 6, the crisis dummy affects only the conditional mean of the term premium. Like in the OLS estimates of column 5, the dummy carries a negative and significant coefficient. The sign pattern of the remaining coefficients is similar to that in column 5. Now, however, all regressors, except for the high-yield spread, carry significant parameter estimates – positive in the case of the U.S. term structure, the EMBI spread and the foreign reserve ratio, and negative for the liquidity ratio of banks. There is strong indication of EGARCH effects, including significant asymmetry that results in positive disturbances increasing the conditional variance more than negative ones. The Q statistics do not reveal residual autocorrelation. However, the autoregressive parameter in the variance equation is close to unity, suggesting that the variance process is close to an integrated EGARCH (IEGARCH).

Column 7 adds the crisis dummy also in the conditional variance equation. It is found to exert a positive and highly significant effect, confirming the finding in Table 4 above that volatility of the term premium rises at times of major shocks. The remaining estimates show very little change relative to those in column 6, and they all continue to be highly significant with the exception of the high-yield spread. We again find a strongly asymmetric impact of disturbances on the conditional variance, but now there is much less evidence of IEGARCH effects. The residuals display no symptoms of autocorrelation.

V. Conclusions

Emerging economies typically show positive interest rate differentials vis-à-vis industrial economies. They reflect two ingredients: the country premium and the currency premium. While the former has been studied in depth by the recent literature, the latter has received much less empirical attention, probably due to lack of adequate data.

Nevertheless, the currency premium has attracted considerable interest in the debate on the choice of exchange rate regime for emerging countries, as well as in the analysis of target zones and covered interest parity, both of which focus mainly on developed countries.

In this paper we have characterized the behavior of the currency premium for two currency boards that have been able to maintain a hard peg to the U.S. dollar for a very long time. Several interesting findings emerge from the paper, and some puzzles are left open for future research. They can be summarized in five main points.

First, despite the presumed rigidity of the peg underlying currency boards, currency premia tend to be uniformly positive, suggesting that markets persistently anticipate a devaluation of the exchange rate. We find very few instances in which the currency premium is negative. This raises the question of whether currency boards really yield sufficient credibility as to minimize currency risk. Of course, to answer the question one would need to examine also the currency premium under other exchange rate regimes; perhaps that observed under currency boards is consistently lower than in other regimes. But in any case the implication is that even full backing of the monetary base does not suffice to eliminate currency risk. The ensuing question is whether dollarization offers the only road to achieve that end.

Second, political and economic events seem to be important factors in the behavior of currency premia. The currency premium in Argentina increased during the Mexican, Asian, Russian, and Brazil crises. Moreover, several political and economic events – such as the crisis ignited in March 2001 – had a large impact on the premium.

Regarding Hong Kong, the currency premium increased significantly during the Mexican crisis, the Asian crisis and, especially, during the attacks on the Hong Kong dollar.

In a related paper we have argued that it is easier for currency regimes to achieve credibility when they are easily verifiable by available data.[28] In this paper we find that Argentine markets reacted negatively to the announcement of a proposal to replace the simple dollar peg underlying the convertibility system with a basket peg composed of U.S. dollars and euros. The immediate result was a jump in the currency premium, as markets perceived the peso to be riskier rather than more stable as the government had intended. This is also consistent with the evidence found during the management of the Mexican crisis. When the government took measures to reinforce the existing currency board, markets welcomed those moves. But any actions viewed as departures from the rigid currency board generated a negative reaction among investors.[29]

Third, the yield curve of currency premia tends to slope upward, but invariably flattens out or turns negative at the peak of crises. This is consistent with previous research that has found short-term premia to be more volatile than long premia, and can be explained by several factors. During financial turmoil, markets may revise upward their perceived probability of immediate collapse of the regime more than the probability of eventual collapse, and/or may anticipate an overshooting of the exchange rate after the collapse. Furthermore, fluctuations in the term structure might also reflect different liquidity in the short- and long-term markets. These fluctuations in term premia imply that one needs to proceed with care when comparing interest rate differentials, currency premia, and country premia of different maturities. A remaining question is whether this

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[28] See Frankel, Fajnzylber, Schmukler, and Servén (2001).

seemingly predictable behavior of term premia generates opportunities for arbitrage. It certainly prompts investors to take speculative bets.

Fourth, we find that prices of currency risk differ across markets. The spread between the forward discount and the currency premium derived from both interbank currency and deposit rates tends to be positive, and increases substantially during times of financial turbulence. This finding admits different interpretations. It might reflect a failure of covered interest parity that leaves unexploited arbitrage opportunities. In principle, domestic banks could arbitrage them away, but anecdotal evidence suggests that at times of financial stress banks prefer to protect their liquidity and refrain from cross-market arbitrage. Alternatively, it is also possible that heterogeneity across markets, reflected in different pricing of the same risk, cannot be arbitraged due to the existence of large transaction costs. In the Argentine case, however, formal transaction costs are not large in the markets we analyze, and they are unlikely to get much larger during crises – although bid-ask spreads can certainly increase at times of high volatility. Finally, the two measures of the currency premium might involve risks not considered in most analyses, such as differential default risk in the exchange and money markets. While our approach focuses on what we have labeled strict covered interest parity, and hence the cross-market differentials that we construct are free from country premia, we cannot rule out this possibility. Thus, without detailed information on market transactions it is not possible to disentangle this puzzle, whose resolution remains open to future research.

Fifth, in the case of Argentina we find that domestic and foreign monetary and financial factors related to risk perceptions and anticipations of devaluation exert a

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[29] See Ganapolsky and Schmukler (2001).

systematic effect on the currency premium and its term structure. Risk related to EMBI spreads, as well as that captured by standard risk ratings, have in most cases a positive effect on currency premia. Reserves – especially hard-currency reserves, more than government-bond reserves – have a negative impact on currency premia, and a positive one on the term premium. The liquidity position of the financial sector, which reflects the risk perceived by financial institutions, affects positively currency premia and negatively the term premium. Finally, adverse domestic and external events that threaten the sustainability of the convertibility system raise the currency premium and tend to invert its term structure.

In this paper we have made some progress towards understanding the currency premium, and we have also raised new puzzles. It would be useful to know whether similar facts and puzzles emerge for other countries and other currency regimes. Preliminary research suggests that this is the case, but the question remains open for future work.

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Appendix: The cross-market currency premium differential

This appendix investigates the differences in the currency premium across instruments in the case of Argentina. Specifically, we study the deviations from the strict version of covered interest parity, as reflected by the difference between the currency premium implied by the NDF and that implied by interbank offer (or lending) interest rates. The interbank market is the most liquid onshore/domestic money market.

We first analyze the different factors behind the cross-market currency premium differential. Specifically, we analyze the influence of transaction costs and default risk as potential explanations for the failure of covered interest parity. Then we study whether the evidence suggests unexploited arbitrage opportunities exist, by assessing the speed of convergence of the cross-market differential to non-arbitrage levels.

A.I Transaction costs and the cross-market currency premium differential

In a world of perfectly integrated markets with no restrictions on capital movements, covered arbitrage would equalize the discount in the forward market with the currency premium implied by interest rates. However, the textbook case of covered interest parity ignores various types of transaction costs that tend to segment the markets. A large empirical literature, originated in the 1970s and 1980s, focuses on testing covered interest parity after taking into account such transaction costs, and examines alternative ways to do arbitrage.[30]

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[30] Much of this literature focuses on identifying "neutral" bands taking into account various transactions costs involved in arbitrage operations. For example, Frenkel and Levich (1977) consider: (i) costs of selling (buying) a domestic security; (ii) costs of buying (selling) spot the foreign currency; (iii) costs of buying (selling) a foreign security; and (iv) the transactions costs of forward coverage. In addition, other papers (e.g., Blenman 1991) consider differentials between borrowing and lending rates and introduce heterogeneous arbitrageurs. Some researchers have used offshore Euromarket rates for these

Here we consider three different arbitrage scenarios. The first one assumes that the arbitrageur has "own" funds. In such case, she will simply compare the currency premium in the foreign exchange rate market and in the money market. The second and third scenarios assume that the arbitrageur does not have funds, and hence she needs to borrow in one currency and lend in the other currency to perform the arbitrage. In this case, the relevant deposit and lending rates need to be considered.

It is important to note that, in each case, there is some risk involved, so there is no pure arbitrage in a strict sense – gains can be realized but at the expense of taking some risks. These have received only limited attention in the literature, however, and thus in each of the scenarios below we highlight the specific risks involved.[31]

Case 1. Arbitrageur with funds

If the arbitrageur has funds invested in the domestic banking sector, she will compare the interbank rates with the forward discount. If the forward discount is greater than the interest rate differential, investors with peso assets will switch their investment to a dollar investment and buy pesos in the forward market. If the forward discount is smaller than the interest rate differential, investors with dollar assets will switch their investment to peso assets and buy dollars in the forward market. If the arbitrageur is a financial institution, the relevant rates are lending rates. Otherwise, the relevant rates are deposit rates. A similar analysis can be performed from the borrowers' side. Hence arbitrage yields two covered parity conditions – one for deposit rates and another for lending rates:

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tests, in addition to the more commonly used onshore domestic currency rates. See also Clinton (1988).

[31] In all three cases we assume that the bid-ask spread in the forward market is negligible. If the spread were significantly different from zero, the parity conditions would need modification to reflect it.

$$\left(i_{t,k}^{lending} - i_{t,k}^{lending,*}\right) = fd_{t,k} = \left(i_{t,k}^{deposit} - i_{t,k}^{deposit,*}\right). \quad \text{(A1)}$$

Thus, if arbitrageurs possessed sufficient funds, they would equalize the currency premia in all three markets.

Note that this arbitrage might not be risk free, since loans and deposits may be subject to default risk. In particular, borrowers might be more likely to repay loans in one currency – typically the local currency – than in the other, as already noted in Section II above.

Case 2. Arbitrageur without funds: borrow and deposit in the same (domestic) market.

The arbitrage in Case 1 might fail to equalize the currency premium across markets if arbitrageurs lack sufficient funds, since in general they may not be able to short deposits. In such case, an alternative form of arbitrage may be possible. If the currency premium implied from the forward market is greater than the one implied from interest rates, the arbitrageur takes a peso loan at the interest rate $i_{t,k}^{lending}$, sells pesos spot and deposits the resulting dollar amount in the domestic market at the rate $i_{t,k}^{deposit,*}$. To cover the position, the arbitrageur buys pesos in the forward market. In the opposite case, if the currency premium implied from the forward market is smaller than that implied from the interest rates, the arbitrageur does the reverse operation. She borrows in dollars and makes a deposit in pesos, buying dollars in the forward market. According to this type of arbitrage, the forward discount lies between two bands

$$\underbrace{\left(i_{t,k}^{lending} - i_{t,k}^{deposit,*}\right)}_{\text{upper band}} \geq fd_{t,k} \geq \underbrace{\left(i_{t,k}^{deposit} - i_{t,k}^{lending,*}\right)}_{\text{lower band}}. \quad \text{(A2)}$$

This arbitrage might impose some risk as well, because the arbitrageur deposits the loan in the domestic financial system. If the domestic bank fails, the arbitrageur may still be liable for the loan she took, even though the bank does not return her own deposit. The arbitrage in case 3 avoids in part this risk.

Case 3. Arbitrageur without funds: borrow in one market and deposit in the other market.

The arbitrage in this case is similar to the one in case 2, but the arbitrageur deposits the dollar value of the peso loan in the offshore market when the currency premium implied from the forward market is greater than the one implied from interest rates. In the opposite case, when the forward discount is smaller than the currency premium implied from interest rates, the arbitrageur borrows in the offshore market and makes a deposit in a domestic bank. This type of arbitrage implies that the forward discount lies within two bands,

$$\underbrace{\left(i_{t,k}^{lending} - {}^{offshore}i_{t,k}^{deposit,*f}\right)}_{\text{upper band}} \geq fd_{t,k} \geq \underbrace{\left(i_{t,k}^{deposit} - {}^{offshore}i_{t,k}^{lending,*f}\right)}_{\text{lower band}}. \qquad \text{(A3)}$$

If offshore deposits are less risky than onshore deposits arbitrage will probably take place when the forward discount is larger than the upper band, since this arbitrage involves relatively no risk. In contrast, when the forward discount is below the lower band arbitrage might not take place, because the arbitrageur would have to bear the differential risk of the onshore bank. The arbitrageur would need to contract a liability in the offshore market and absorb the onshore risk.

A.II Default risk and the cross-market currency premium differential

Even onshore instruments issued by the same borrower in different currencies may pose different default risks – e.g., default probabilities and/or recovery ratios in the event of default may differ systematically across assets depending on their currency of denomination. In such case, the onshore interest differential (10) would equal the forward premium plus another term (positive or negative) reflecting the different default characteristics of domestic- and foreign-currency denominated instruments.[32]

As an example, consider the case in which domestic debtors default with probability 1-α (respectively, 1-α*) on their domestic (foreign-currency) one-period liabilities, whose respective gross yields are $R_{t,1}$ and $R^*_{t,1}$, and assume that in the event of default the corresponding recovery values are $\theta R_{t,1}$ and $\theta^* R^*_{t,1}$, where θ, $\theta^* < 1$. Risk-neutral speculation across the two assets, using the forward market,[33] can be shown to imply

$$(i_{t,1} - i^*_{t,1}) = fd_{t,1} - \ln\left[1 + \frac{(1-\alpha)(\theta - \theta^*)}{\alpha^* + (1-\alpha^*)\theta^*} + \frac{(\alpha - \alpha^*)(1-\alpha^*)}{\alpha^* + (1-\alpha^*)\theta^*}\right]. \qquad \text{(A4)}$$

Comparing this expression with (10) above, it is immediately apparent that covered interest parity fails to hold except if $\alpha = \alpha^*$ and $\theta = \theta^*$, i.e., when default probabilities and recovery ratios are identical across assets. Otherwise, the observed interest rate differential falls short of the forward premium if domestic-currency assets

[32] Note also that forward exchange contracts themselves may not be free of counterparty default risk; see Hodrick (1987). As discussed in the text, this risk is considerably smaller in the case of the non-deliverable forward contracts, which we use in our empirical work here, than in the case of outright forward contracts.

[33] Note that in this case forward arbitrage is not risk-free anymore due to the existence of default risk – even though it is free of exchange rate risk.

entail a lower probability of default ($\alpha > \alpha$*) and/or a higher recovery ratio ($\theta > \theta^*$) than foreign-currency assets. If the reverse is true, then the observed interest rate differential exceeds the forward premium.[34]

A.III Unexploited arbitrage opportunities?

We next review in more detail how different markets price currency risk. First we assess whether the evidence from Argentina seems consistent with no-arbitrage opportunities. To do this, Appendix Figure 1 displays three charts. The top panel plots the 1-month forward discount along with the currency premium derived from 1-month lending and deposit rates. The middle panel plots the forward discount along with the upper and lower bands described in equation (A2), while the bottom panel uses the bands displayed in equation (A3).

Appendix Figure 1 shows that the forward discount differs from the currency premium derived from interbank rates. For most of the sample the two measures are roughly similar, but in many instances the forward discount is significantly different from the interbank market currency premium. This is especially the case during turbulent times and at the end of the sample, when the forward discount becomes considerably larger than the currency premium derived from interbank rates. The forward discount has very few values below the interbank currency premium.

A similar picture is displayed in the middle and lower panels of Appendix Figure 1, corresponding to cases 2 and 3 above. In these panels the forward discount lies for the most part within the no-arbitrage bands. But in some observations, particularly at the end

[34] On this point, see also Broda and Levy Yeyati (2001).

of the sample, the forward discount jumps above the upper band. As we shall discuss below, these are not just one-day events. The lower panel uses offshore deposit and lending rates. Relative to the middle panel, the bands shift upward because country risk is not present in the offshore rates. These rates are lower than domestic interbank rates, so the differential shrinks. Despite the upward shift in the band, the forward discount still lies above the band during crisis times. But in this case there exist a few observations in which the forward discount lies below the lower band.

Does this evidence imply that arbitrage opportunities exist? The answer is just maybe. There are three alternative explanations for the evidence found; we have already mentioned two of them.[35] One explanation is that in fact there are unexploited arbitrage opportunities in the short run and, thus, covered interest parity fails to hold. The currency premium derived from the exchange market is significantly different from the one derived from the money market, and is larger than any existing transaction costs. For some reason, arbitrage does not take place.[36]

A second possible explanation is that unobserved transaction costs – aside from the spread between lending and borrowing rates considered above – are large enough to rule out profitable arbitrage opportunities. However, this argument does not explain why

[35] In fact, there is a fourth explanation, which claims that data might not be well aligned by time of day. This can generate differences across markets, as shown by McCormick (1979). In our case, we use closing daily data, which in terms of trading hours are reasonably aligned. The trading hours in Buenos Aires are the same as those in New York, while trading hours in Hong Kong are similar to those in other financial centers in Asia. Given the regularities found in the data for both Argentina and Hong Kong, we believe that lack of perfect data alignment is not explaining the cross-market differences. We thank Maury Obstfeld for raising this point.

[36] Informal evidence gathered from market participants suggests that at times of turbulence, when the forward premium becomes quite large, domestic banks refrain from getting involved in short-term arbitrage operations and prefer to "stay liquid." While this is consistent with the opening of a gap between the interbank and forward currency premia, the precise reasons for this decision are not known to us.

the different markets exhibit systematically different currency premia. The cross-market differentials might reflect the action of heterogeneous agents, endowed with different expectations, in the various markets. In this case, the cross-market differential will lie within bounds determined by the magnitude of these unspecified transaction costs, similarly to (A2) and (A3) above.

In the case of Argentina, however, there are no obvious transaction costs to support this explanation. There are no restrictions on capital movements, and local residents can operate in the local and foreign markets without being taxed on interest, dividend, or capital gains.[37] Yet the fact that currency premia are not equal across markets suggests that other types of transaction costs or market imperfections leading to market segmentation could be responsible for our findings. For example, there could be large bid-ask spreads unknown to us in the forward market,[38] or it might not be possible to perform transactions at quoted prices. In view of the large volume of transactions in the NDF market, however, this explanation does not seem very convincing.

A third possible explanation for our findings is that the differences in currency premia reflect in fact differences in other risks across markets. In other words, the measures of the currency premium that we (and the rest of the literature) use embed other types of risks and do not solely measure "currency risk." In such case, the cross-market currency premium differential could reflect default risk. Specifically, borrowers or banks

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[37] In April 2001 a small transaction tax of 0.2 percent was imposed on some financial transactions in Argentina, what cannot explain the large differentials found before and after that date. In countries with substantial explicit costs, like capital controls, there is a wedge between local and foreign rates, as shown by Herrera and Valdés (2001) for the case of Chile.

[38] Data on bid-ask spreads from NDFs are not available. However, we were able to obtain data on bid-ask spreads from the peso spot market. The maximum annualized spread from this market is 240 basis points. Unless spreads on NDFs are much larger than those on spot transactions, they will be unable to

might be more likely to default on dollar loans and deposits than on peso contracts.[39] As a result, the forward discount would exceed the peso-dollar interest differential by a default premium along the lines of equation (A4) in the text.[40]

In sum, at one extreme the discrepancy between the forward discount and the currency premium derived from interbank rates might reflect divergent expectations that are not or cannot be arbitraged away. At the other extreme, the discrepancy might reflect the perceived default risks in the interbank market. Transaction costs might also play a role. Of course, it is also possible that the three explanations are simultaneously behind the cross-market differentials. It is difficult to disentangle these alternative explanations without much more detailed information on market transactions.

A.IV Convergence of the cross-market currency premium differential

Though we cannot determine exactly the source of the spread between the forward discount and the interbank currency premium, it is still interesting to study its behavior, as it provides information about the differential behavior of both markets. Formally, we define the spread between the forward and the interbank market as follows

$$\delta_{t,k} = fd_{t,k} - \left(i_{t,k} - i^{*}_{t,k}\right). \qquad \text{(A5)}$$

explain the observed cross-market differences. We thank Amadou Sy for generously providing us the data.

[39] Collin-Dufresne and Solnik (2001) describe a similar case for the swap and LIBOR markets.

[40] An alternative version of the same argument would resort to systematic differences in default risks between domestic banks operating in dollars and those operating in pesos. In Argentina, however, virtually all banks borrow and lend in both currencies.

These interbank rates can be either lending or deposit rates. Here we shall work with lending rates, since they display much more variability than deposit rates (see Figure 2 in the text) and hence their behavior resembles more closely that of the NDF premium.

The literature on covered interest parity has employed two main approaches to analyzing this spread. The first one simply takes the observed deviations from covered interest parity and assesses whether they frequently exceed what would be justified by transaction costs. The second approach performs unit root tests on the covered interest differential to determine whether non-stationarity can be rejected; failure to reject non-stationarity implies that the covered differential persists indefinitely and thus covered interest parity fails to hold. Still, even if non-stationarity is rejected the covered differential may converge very slowly to its mean, reflecting persistent (albeit not permanent) failures of covered interest parity.

In our case, we take the case most favorable to covered interest parity – namely that in which the arbitrageurs have no funds (Cases 2 and 3 above). We also work with the onshore rates used in the strict form of covered interest parity described in Section II. We then examine the behavior of the forward discount relative to the no-arbitrage band defined by borrowing and lending rates, using the band displayed in the middle panel of Appendix Figure 1. For those observations where the forward discount lies above the band, we examine the dynamics of the differential between the forward discount and the upper band. For the observations inside the band, we study the dynamics of the forward discount.[41]

[41] Since we have no observations below the lower band, we ignore this case.

This approach is in the spirit of the threshold autoregression (TAR) models used to study arbitrage in goods and assets markets.[42] These models typically need to estimate the "commodity points" or thresholds of no arbitrage. In our case, however, the problem is simpler because the thresholds are known, and given by the no-arbitrage bands in Figure A1. Therefore, we estimate the following model:

$$\begin{cases} \Delta\left(fd_{t,k}-\left(i_{t,k}-i^{*}_{t,k}\right)\right) = c^{out}+\lambda^{out}\left(fd_{t-1,k}-\left(i_{t-1,k}-i^{*}_{t-1,k}\right)\right)+\varepsilon^{out}_{t,k} & \text{if } fd_{t,k}>\left(i_{t,k}-i^{*}_{t,k}\right) \\ \Delta fd_{t,k} = c^{in}+\lambda^{in} fd_{t-1,k}+\varepsilon^{in}_{t,k} & \text{if } fd_{t,k}\le\left(i_{t,k}-i^{*}_{t,k}\right) \end{cases} \quad \text{(A6)}$$

Note that the mean and the speed of adjustment, as well as the variance of the disturbance, are allowed to differ across equations. Our primary concern is to assess the speed of adjustment λ both within and outside the band.

The top panel of Appendix Table 1 shows the number of observations for which the forward discount lies outside and inside the no-arbitrage band. Around 49 percent of the observations are above the no-arbitrage bands (345 observations). The histogram displayed in the table shows the distribution of observations relative to the upper band. Negative numbers represent observations below the upper band, while positive numbers are observations above the band. The histogram shows that the observations above the band can take very large values – their median exceeds 1,000 basis points.

The bottom of Appendix Table 1 reports the results from estimating the TAR model. Since the observations above the upper band clearly become more abundant in the latter part of the sample, we perform the estimation on two different samples: the full

[42] These models have been used to examine issues such as the validity of purchasing power parity, or the extent of arbitrage under the gold standard. See for example, Obstfeld and Taylor (1997), Prakash and Taylor (1997), Taylor and Peel (2000), and Taylor, Peel, and Sarno (2001).

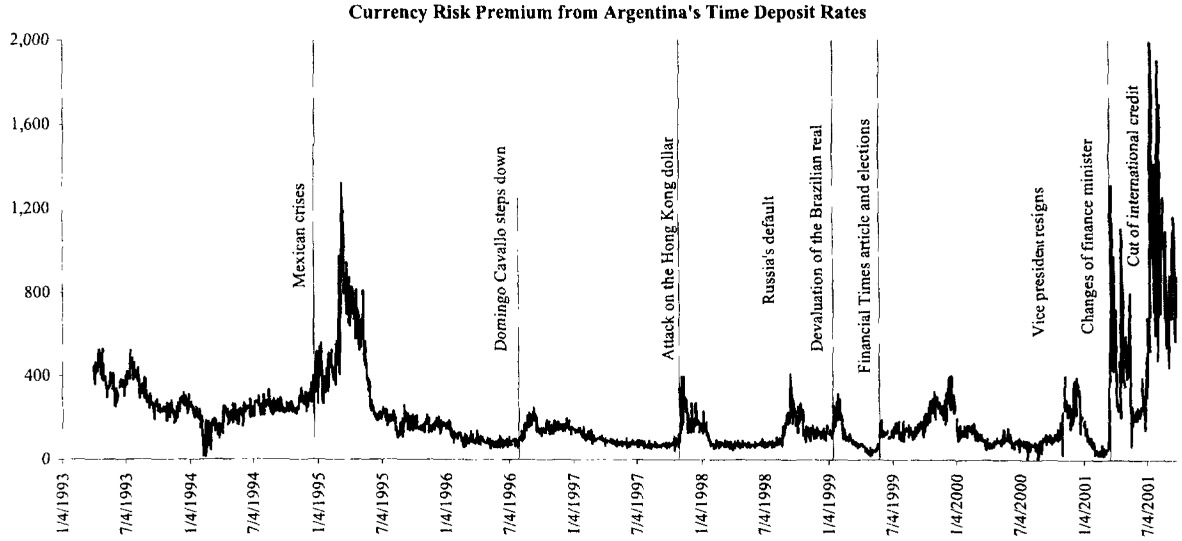
sample of available data, and a subsample ending at the time of the cut in international financing (early July 2001).

For the observations outside the band we can reject nonstationarity of the dependent variable. The estimates reflect reversion to the mean. Interestingly, for the observations inside the band we cannot reject nonstationarity. The speed of adjustment to the mean appears to have declined dramatically after the cut in international lending of July 2001. This is particularly evident from the half-life of the differential [calculated as $\ln(0.5)/\ln(1+\lambda)$] outside the band, which is one and a half day in the restricted sample and nearly five days in the full sample. Hence, departures from the arbitrage band appear to have become much more lasting – indeed, much more lasting than should be expected under perfect arbitrage.

To conclude, we document the main features of the cross-market currency premium differential, as a reflection of unspecified heterogeneity across markets rather than specifically as a potential failure of covered arbitrage. Appendix Figure 2 plots the 1-month forward-interbank spread $\delta_{t,k}$, while Appendix Table 2 displays summary statistics of the spread for the 1- and 12-month maturities. The spread is on average positive, particularly for the 1-month maturity. But the mean is affected by large positive values reaching as high as 11,000 basis points during the 2001 crisis. The distribution is skewed to the right, so that the median is smaller than the mean, but still positive. It is noteworthy that all the large values take place during crisis times. In tranquil times, the cross-market difference is also positive but smaller. The differential takes on only a few negative numbers, reaching at most –200 basis points.

Figure 1
Currency Premia under Currency Boards

The figure shows historical values of daily currency premia in Argentina (top panel) and Hong Kong (lower panel). The currency premium for Argentina is calculated as the spread of local peso time deposit rates over local U.S. dollar interbank deposit rates, with maturities up to 2 months. The currency premium for Hong Kong is calculated with the forward discount, the forward exchange rate minus the spot exchange rate, using 1-month contracts. The sample for Argentina covers the period 4/1/93 - 9/25/01, for Hong Kong it covers the period 1/4/93 - 9/25/01. All rates are in basis points, annualized, and continuously compounded.



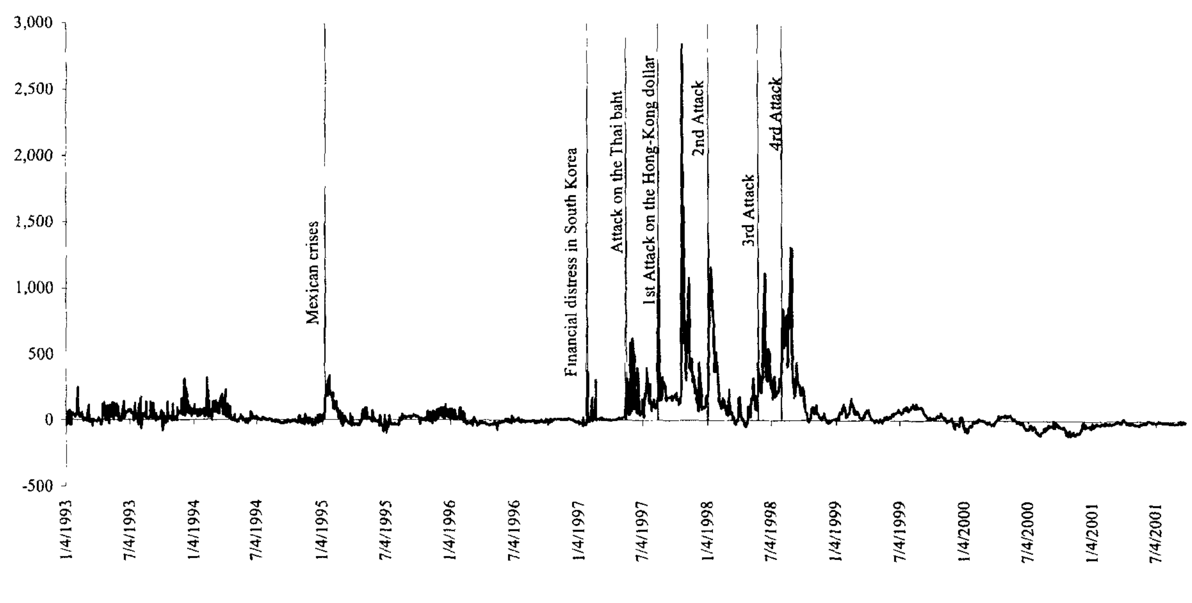
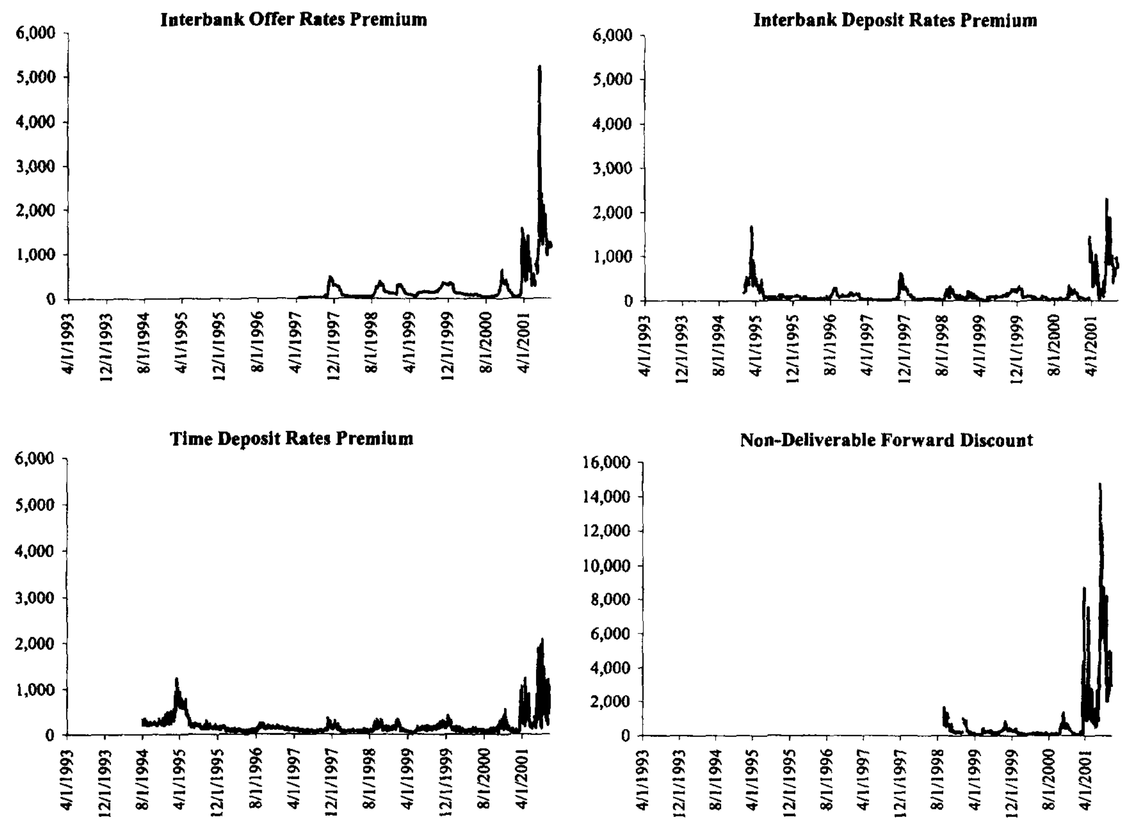


Figure 2
Alternative of Measures of Currency Premia

The figure shows different measures of currency premia for Argentina and Hong Kong, using daily 1-month interest rate premia and 1-month forward exchange rate discounts. The interest rates used for Argentina include the interbank offer rate (BAIBOR), the interbank deposit rate index or money market index (MMR) consisting of rates paid on deposits of more than 1 million pesos or U.S. dollars, and the time deposit rate for deposits up to 1 million pesos or U.S. dollars. Both the BAIBOR and the MMR are from Bloomberg and the time deposit rates were obtained from the Central Bank of Argentina. For each type of rate, the currency premium for Argentina is measured by the difference between the rate denominated in domestic currency and that in U.S. dollars. The forward exchange rates for Argentina are non-deliverable forward (NDF) rates and the NDF currency premium is measured by the forward discount. NDF forward rates are from two sources: Deutsche Bank and Bloomberg.
The interest rates used for Hong Kong are interbank offer rates (HIBOR), obtained from the Hong Kong Monetary Authority. The premium is obtained over the U.S.-dollar LIBOR. The forward rates used for Hong Kong are from Bloomberg and correspond to deliverable contracts. All the rates are annualized, in basis points, and continuously compounded.

Argentina



Hong Kong

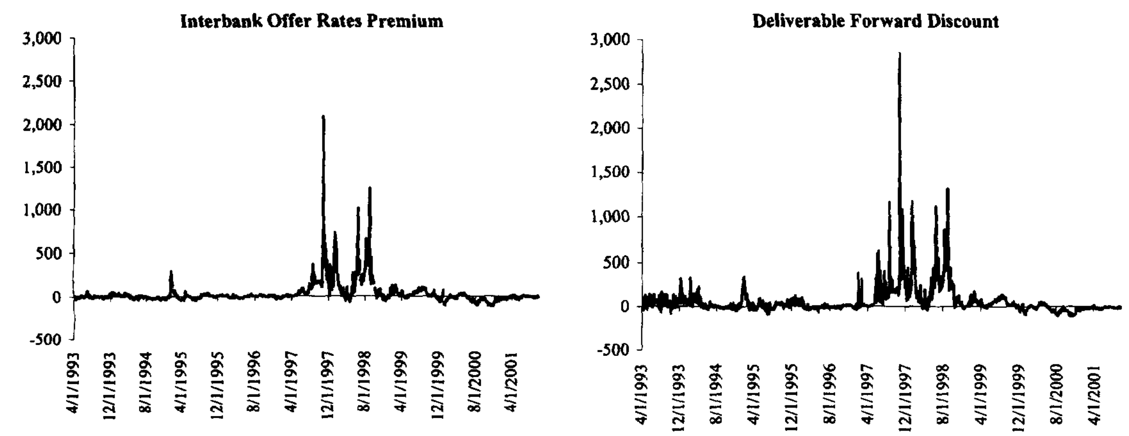


Figure 3
Term Structure of Currency Premia

The figure shows the term structure of the currency premium in Argentina (top panel) and Hong Kong (bottom panel), calculated with the difference between the 12-month and the 1-month currency premium. For each country, the currency premium is measured using both interbank offer rates and forward exchange rates. For Argentina the peso interbank offer premium is obtained with the spread of peso over dollar denominated Argentine interbank offer rates, while for Hong Kong the interbank offer premium is measured with the spread of the Hong Kong interbank offer rates over the U.S.-dollar LIBOR. The forward discounts are measured by the spreads of non-deliverable forward (NDF) exchange rates, for Argentina, and deliverable forward rates, for Hong Kong, over the spot exchange rate, respectively. The interest rates for Hong-Kong were obtained from the Hong Kong Monetary Authority and the exchange rates from Bloomberg. The Argentine interbank rates are from Bloomberg and the NDF rates were obtained from Deutchbank and Bloomberg. All the rates are annualized, in basis points, and continuously compounded.

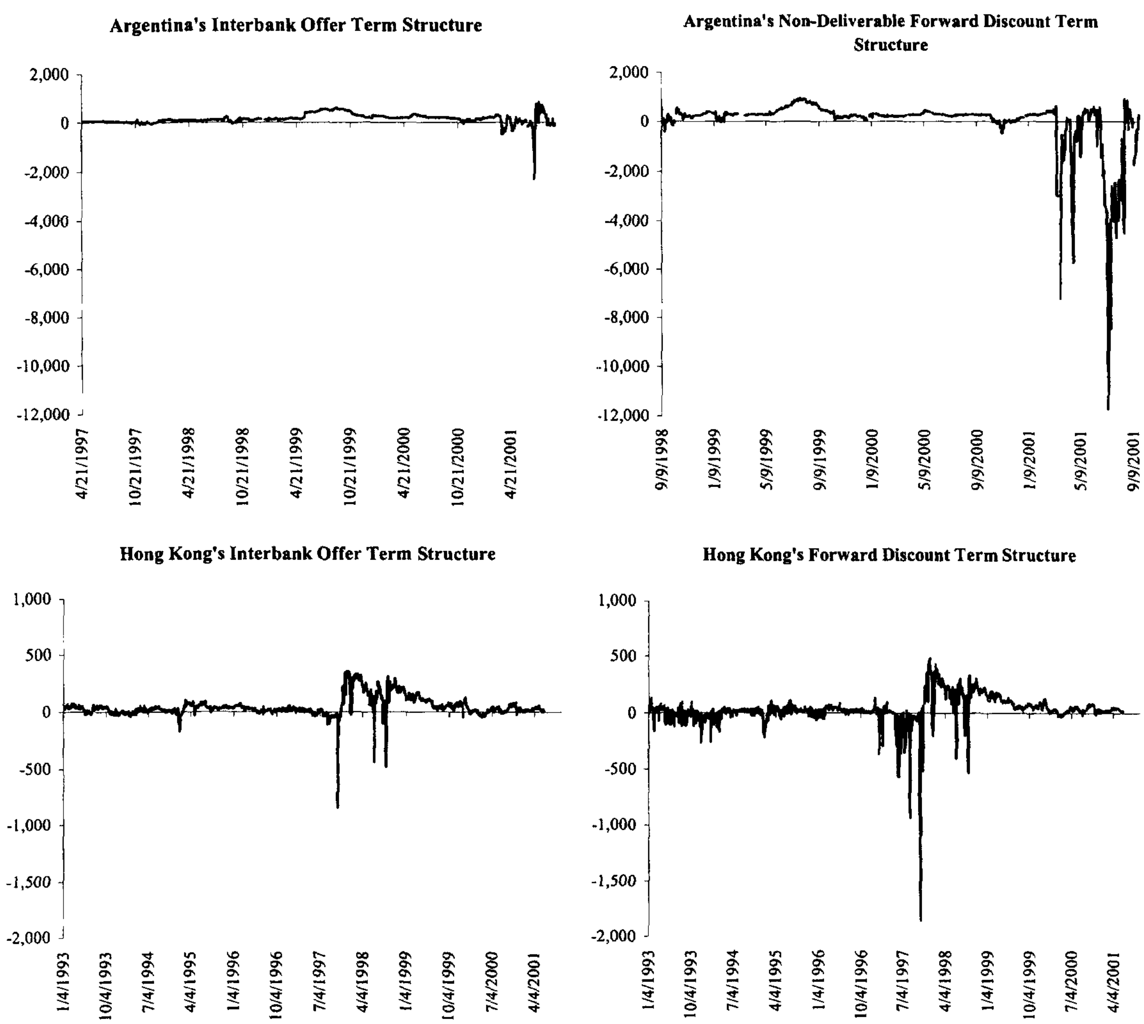


Table 1
History of Currency Premia in Argentina and Hong Kong
Summary Statistics

The table shows summary statistics of daily currency premia in Argentina and Hong Kong for different samples. The currency premium for Argentina is calculated as the spread of local peso time deposit rates over local U.S. dollar interbank deposit rates, with maturities up to 2 months. The currency premium for Hong Kong is calculated with the 1-month forward discount. The crisis periods for Argentina are the following: (i) Mexican crisis, (ii) Attack on the Hong Kong dollar, (iii) Russia's default, (iv) Devaluation of the Brazilian real, (v) Financial Times article and presidential elections, (vi) Vice president resigns, (vii) Changes of finance minister, and (viii) Cut of international credit. The crisis periods for Hong-Kong are: (i) The Mexican crisis, (ii) the Financial distress in Korea, (iii) the Attacks on the Thai baht and the four attacks on the Hong Kong dollar. See text for a description of all the events. All rates are in basis points, annualized, and continuously compounded.

	Dates	*Number of Observations*	*Mean*	*Median*	*Standard Deviation*	*Min*	*Max*
Argentina							
Time Deposit Rates							
Up to 2 month							
Total	04/01/93 - 06/05/01	2,121	211	148	204	1	1,986
Tranquil Periods (after the Mexican Crisis)		1,228	126	98	97	1	812
Crisis Periods		446	383	252	333	25	1,986
Mexican crisis	01/10/95 - 04/10/95	63	603	520	243	264	1,316
Attack on the Hong Kong dollar	10/29/97 - 11/26/97	21	223	223	90	83	393
Russia's default	08/19/98 - 10/16/98	42	201	193	69	65	405
Devaluation of the Brazilian real	01/13/99 - 02/12/99	23	210	206	56	97	315
Financial Times article and elections	05/17/99 - 12/17/99	149	186	155	74	88	397
Vice president resigns	10/06/00 - 12/29/00	56	216	220	90	25	397
Changes of finance minister	03/16/01 - 05/18/01	38	548	480	252	202	1,308
Cut of international credit	07/10/01 - 09/25/01	54	1,005	940	359	441	1,986
Hong Kong							
Forward Rates							
Total	01/04/93 - 06/05/01	2,240	58	12	165	-111	2,840
Tranquil Periods		1,908	15	6	53	-111	325
Crisis Periods		332	301	217	313	-47	2,840
Mexican crisis	01/10/95 - 04/10/95	62	73	38	106	-47	341
Early signs of financial distress	01/27/97 - 02/21/97	19	50	9	112	-19	376
Attack on the Thai Bath	05/14/97 - 7/24/97	51	182	101	163	23	621
1st Attack on the Hong-Kong dollar	08/15/97 - 12/15/97	87	386	225	398	70	2,840
2nd Attack on the Hong-Kong dollar	01/05/98 - 02/04/98	22	598	491	293	147	1,165
3rd Attack on the Hong-Kong dollar	05/27/98 - 07/06/98	29	418	348	205	212	1,119
4th Attack on the Hong-Kong dollar	07/10/98 - 10/06/98	62	426	306	272	178	1,309

Table 2
Maximum Implied Devaluation in Argentina and Hong Kong
Summary Statistics

The table shows the maximum devaluation implied by the currency premium in Argentina and Hong Kong, for different probabilities of devaluation and different sample periods. Under risk neutrality, the currency premium is equal to the probability of devaluation times the value of the devaluation. Therefore, the maximum implied devaluation is obtained by dividing the maximum currency premium observed in each sample period by the assumed probability of devaluation. The currency premium for Argentina is calculated as the spread of local peso time deposit rates over local U.S. dollar interbank deposit rates, with maturities up to 2 months. The currency premium for Hong Kong is calculated with the 1-month forward discount.
The crisis periods for Argentina are the following: (i) Mexican crisis, (ii) Attack on the Hong Kong dollar, (iii) Russia's default, (iv) Devaluation of the Brazilian real, (v) Financial Times article and presidential elections, (vi) Vice president resigns, (vii) Changes of finance minister, and (viii) Cut of international credit. The crisis periods for Hong-Kong are: (i) The Mexican crisis, (ii) the Financial distress in Korea, (iii) the Attacks on the Thai baht and the four attacks on the Hong Kong dollar. See text for a description of all the events. All rates are in basis points, annualized, and continuously compounded.

	Dates	*10%*	*25%*	*50%*	*75%*	*90%*
Argentina						
Time Deposit Rates						
Up to 2 month						
Total	04/01/93 - 06/05/01	19,861	7,944	3,972	2,648	2,207
Tranquil Periods (after the Mexican Crisis)		8,122	3,249	1,624	1,083	902
Crisis Periods		19,861	7,944	3,972	2,648	2,207
Mexican crisis	01/10/95 - 04/10/95	13,165	5,266	2,633	1,755	1,463
Attack on the Hong Kong dollar	10/29/97 - 11/26/97	3,934	1,574	787	525	437
Russia's default	08/19/98 - 10/16/98	4,052	1,621	810	540	450
Devaluation of the Brazilian real	01/13/99 - 02/12/99	3,146	1,258	629	419	350
Financial Times article and elections	05/17/99 - 12/17/99	3,968	1,587	794	529	441
Vice president resigns	10/06/00 - 12/29/00	3,974	1,590	795	530	442
Changes of finance minister	03/16/01 - 05/18/01	13,078	5,231	2,616	1,744	1,453
Cut of international credit	07/10/01 - 09/25/01	19,861	7,944	3,972	2,648	2,207
Hong Kong						
Forward Rates						
Total	01/04/93 - 06/05/01	28,398	11,359	5,680	3,786	3,155
Tranquil Periods		3,252	1,301	650	434	361
Crisis Periods		28,398	11,359	5,680	3,786	3,155
Mexican crisis	01/10/95 - 04/10/95	3,409	1,364	682	455	379
Early signs of financial distress	01/27/97 - 02/21/97	3,760	1,504	752	501	418
Attack on the Thai Bath	05/14/97 - 7/24/97	6,213	2,485	1,243	828	690
1st Attack on the Hong-Kong dollar	08/15/97 - 12/15/97	28,398	11,359	5,680	3,786	3,155
2nd Attack on the Hong-Kong dollar	01/05/98 - 02/04/98	11,651	4,660	2,330	1,553	1,295
3rd Attack on the Hong-Kong dollar	05/27/98 - 07/06/98	11,187	4,475	2,237	1,492	1,243
4th Attack on the Hong-Kong dollar	07/10/98 - 10/06/98	13,090	5,236	2,618	1,745	1,454

Table 3
Alternative Measures of Currency Premia
Summary Statistics

The table shows summary statistics for different measures of currency premia for Argentina and Hong Kong, using daily 1-month interest rates and 1-month forward exchange rate discounts from 9/9/98 to 9/25/01 for Argentina and 1/4/93 to 9/25/01 for Hong Kong. The differences in the number of observations are due to missing values. The interest rates used for Argentina include the interbank offer rate (BAIBOR), the interbank deposit rate index or money market index (MMR) consisting of rates paid on deposits of more than 1 million pesos or U.S. dollars, and the time deposit rate for deposits up to 1 million pesos or U.S. dollars. Both the BAIBOR and the MMR are from Bloomberg and the time deposit rates were obtained from the Central Bank of Argentina. For each type of rate, the currency premium for Argentina is measured by the difference between the rate denominated in domestic currency and that in U.S. dollars. The forward exchange rates for Argentina are non-deliverable forward (NDF) rates and the NDF currency premium is measured by the forward discount. NDF forward rates are from two sources: Deutsche Bank and Bloomberg.
The interest rates used for Hong Kong are interbank offer rates (HIBOR), obtained from the Hong Kong Monetary Authority. The premium is obtained over the U.S.-dollar LIBOR. The forward rates used for Hong Kong are obtained from Bloomberg and correspond to deliverable contracts. All the rates are annualized, in percentages, and continuously compounded.

	Number of Observations	*Mean*	*Median*	*Standard Deviation*	*Min*	*Max*
Argentina						
Interbank Offer Rates	720	318	144	487	29	5,217
Time Deposit Rates	726	214	126	271	-4	2,067
Interbank Deposit Rates	704	206	93	312	0	2,305
Non-Deliverable Forward Rates	737	857	228	1,772	42	14,726
Hong Kong						
Interbank Offer Rates	2,090	39	1	150	-115	3,336
Deliverable Forward Rates	2,240	58	12	165	-111	2,840

Correlations

	Interbank Offer Rates	Time Deposit Rates	Interbank Deposit Rates	Non-Deliverable Forward Rates
Interbank Offer Rates	1			
Time Deposit Rates	0.83	1		
Interbank Deposit Rates	0.89	0.78	1	
Non-Deliverable Forward Rates	0.91	0.82	0.85	1

	Interbank Offer Rates	Deliverable Forward Rates
Interbank Offer Rates	1	
Deliverable Forward Rates	0.94	1

Table 4
Term Structure of Currency Premia
Summary Statistics

The table shows the summary statistics for the term premia, spread between the currency premium measured with 12-month rates over the one from 1-month rates, during crisis and tranquil periods, for Argentina and Hong Kong. The crisis periods for Argentina are the following: (i) Mexican crisis, (ii) Attack on the Hong Kong dollar, (iii) Russia's default, (iv) Devaluation of the Brazilian real, (v) Financial Times article and presidential elections, (vi) Vice president resigns, (vii) Changes of finance minister, and (viii) Cut of international credit. The crisis periods for Hong-Kong are: (i) The Mexican crisis, (ii) the Financial distress in Korea, (iii) the Attacks on the Thai baht and the four attacks on the Hong Kong dollar. See text for a description of all the events. All rates are in basis points, annualized and continuously compounded.

	Dates	*Number of Observations*	*Mean*	*Median*	*Standard Deviation*	*Min*	*Max*
Argentina							
Interbank Offer Rates							
Total	04/21/97-06/05/01	1,098	168	151	204	-2,283	864
Tranquil Periods		720	139	134	95	-238	442
Crisis Periods		378	222	198	315	-2,283	864
Attack on the Hong Kong dollar	10/29/97 - 11/26/97	21	-24	-30	35	-81	54
Russia's default	08/19/98 - 10/16/98	42	81	49	95	-59	258
Devaluation of the Brazilian real	01/13/99 - 02/12/99	23	130	131	31	54	193
Financial Times article and elections	05/17/99 - 12/17/99	149	444	486	126	200	627
Vice president resigns	10/06/00 - 12/29/00	56	124	130	47	-41	188
Changes of finance minister	03/16/01 - 05/18/01	38	-73	-114	249	-491	311
Cut of international credit	07/10/01 - 09/25/01	49	158	222	621	-2,283	864
NDF Rates							
Total	10/20/97-06/05/01	732	-12	270	1,198	-11,720	984
Tranquil Periods (after the Mexican Crisis)		393	231	282	423	-3,667	643
Crisis Periods		339	-293	160	1,657	-11,720	984
Russia's default	08/19/98 - 10/16/98	27	66	-1	278	-481	579
Devaluation of the Brazilian real	01/13/99 - 02/12/99	22	157	135	139	-120	337
Financial Times article and elections	05/17/99 - 12/17/99	143	502	490	276	44	984
Vice president resigns	10/06/00 - 12/29/00	56	33	46	159	-485	297
Changes of finance minister	03/16/01 - 05/18/01	38	-1,295	-846	1,648	-7,200	251
2 Cut of international credit	07/10/01 - 09/25/01	53	-2,430	-2,348	2,872	-11,720	941
Hong Kong							
Interbank Offer Rates							
Total	01/04/93-06/05/01	2,065	49	30	81	-836	358
Tranquil Periods		1,754	50	32	69	-51	358
Crisis Periods		311	44	17	130	-836	346
Mexican crisis	01/10/95 - 04/10/95	59	24	58	65	-175	99
Early signs of financial distress	01/27/97 - 02/21/97	18	18	19	9	-7	38
Attack on the Thai Bath	05/14/97 - 7/24/97	46	-8	-11	20	-44	25
1st Attack on the Hong-Kong dollar	08/15/97 - 12/15/97	81	6	-34	152	-836	345
2nd Attack on the Hong-Kong dollar	01/05/98 - 02/04/98	20	137	169	139	-24	346
3rd Attack on the Hong-Kong dollar	05/27/98 - 07/06/98	28	81	104	129	-437	269
4th Attack on the Hong-Kong dollar	07/10/98 - 10/06/98	59	118	156	158	-483	316
Forward Rates							
Total	01/04/93-06/05/01	2,152	37	25	118	-1,854	481
Tranquil Periods		1,820	45	26	81	-269	481
Crisis Periods		332	-9	-6	228	-1,854	430
Mexican crisis	01/10/95 - 04/10/95	62	-16	11	79	-217	108
Early signs of financial distress	01/27/97 - 02/21/97	19	-37	7	113	-366	28
Attack on the Thai Bath	05/14/97 - 7/24/97	51	-143	-55	160	-570	3
1st Attack on the Hong-Kong dollar	08/15/97 - 12/15/97	87	-76	-37	312	-1,854	354
2nd Attack on the Hong-Kong dollar	01/05/98 - 02/04/98	22	139	263	219	-205	430
3rd Attack on the Hong-Kong dollar	05/27/98 - 07/06/98	29	93	125	163	-405	263
4th Attack on the Hong-Kong dollar	07/10/98 - 10/06/98	62	114	175	186	-532	334

Table 5
Determinants of Currency Premia in Argentina

The columns of the table show the results for regressions of the 1-month currency premium on a set o explanatory variables. Columns 1 to 5 correspond to ordinary least squares (OLS) regressions and columns 6 and 7 extend the model to an exponential garch (EGARCH). The models estimated are described in equations (15) and (16) in the paper. The first column of the table shows the results for the basic specification, including as regressors (i) the spread of a high yield bond index over a comparable U.S. government bond, (ii) the EMBI spread of Latin American countries excluding Argentina, and (iii) the ratio of total reserves of the central bank to total deposits and (iv) the ratio of total cash held by the financial system over total deposits. The second specification, column (2), adds the Golman Sachs measure of currency mislignment. Specification (3) disaggregates the reserves of the central bank into the ratio of reserves held in the form of government bonds to total deposits and the ratio of hard currency reserves to total deposits. Specification (4) tests the effect of Argentina's average foreign currency credit rating.
The last OLS specification, in column (5), tests the effects of external and internal shocks on the conditional mean with two dummy variables. The external shocks dummy captures the effect of the Russian default and the Brasilian devaluation, while the internal shocks dummy captures the effects of the internal crisis periods during 1999 and 2001: Financial Times article and presidential elections, Vice president resigns, Changes of Finance Minister, and Cut of international credit. In all OLS specifications 4 lags in differences of the dependent variable and all regressors were included. In the EGARCH specifications the lags for the reserves and cash ratios could be treammed down to two, allowing for a larger sample which improves convergence. The EGARCH specifications use the basic set of regressors and a dummy variable for all crisis (internal and external): column (6) tests for the effects of the crisis dummy in the conditional mean and the last specification, column (7), tests for its effects also in the conditional variance. Standard errors are in parentheses. * significant at 10%, ** at 5%, and *** at 1%.

Dependent variable in First Differences:	1-month NDF Discount (f1-s)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lagged Dependent Variable	-0.326 ***	-0.331 ***	-0.319 ***	-0.369 ***	-0.369 ***	-0.129 ***	-0.140 ***
	(0.066)	(0.067)	(0.064)	(0.073)	(0.074)	(0.010)	(0.005)
High Yield Spread	-0.161	1.035	-0.424	1.343	1.071	0.219 **	-0.635 ***
	(0.952)	(1.095)	(0.855)	(0.902)	(1.025)	(0.101)	(0.045)
GS Misalignment Measure		0.079					
		(0.131)					
LAC EMBI Spread	0.640 ***	0.369 ***	0.666 ***	0.438 **	0.287	0.013	0.033 ***
	(0.236)	(0.115)	(0.230)	(0.211)	(0.189)	(0.016)	(0.010)
Total Reserves to Deposits Ratio (t-3)	-0.327 ***	-0.441 ***		-0.185	-0.248 *	-0.109 ***	-0.009 ***
	(0.117)	(0.112)		(0.133)	(0.128)	(0.007)	(0.003)
Bomd Reserves to Deposits Ratio (t-3)			-0.040				
			(0.032)				
Hard Currency Reserves to Deposits Ratio (t-3)			-0.292 **				
			(0.114)				
Banks' Cash over Deposits Ratio (t-3)	0.169 ***	0.162 ***	0.161 ***	0.115 **	0.283 ***	0.048 ***	0.007 ***
	(0.049)	(0.055)	(0.046)	(0.050)	(0.082)	(0.003)	(0.001)
Average Foreign Currency Credit Rating				-8.598 **			
				(3.892)			
External Shocks (Russia and Brasil)					1.957 *		
					(1.004)		
Internal Shocks					3.358 **		
					(1.465)		
Crisis Dummy						0.494 ***	0.660 ***
						(0.061)	(0.046)
constant	9.584	-1.398	-6.313	47.254 **	55.715 *	3.125 ***	1.772 ***
	(13.462)	(16.047)	(15.902)	(22.297)	(29.490)	(0.976)	(0.131)
time	0.007		0.007	0.000	0.007	0.000 ***	0.001 ***
	(0.005)		(0.005)	(0.004)	(0.005)	(0.000)	(0.000)
earch						-0.468 ***	0.045
						(0.064)	(0.091)
arch-abs.						2.590 ***	2.746 ***
						(0.108)	(0.097)
egarch						0.918 ***	0.828 ***
						(0.016)	(0.018)
Crisis Dummy							1.611 ***
							(0.129)
constant						-0.029	-0.692 ***
						(0.079)	(0.098)
Number of observations	378	358	378	378	378	454	454
R^2	0.40	0.42	0.41	0.41	0.42		
Maximum number of lags	4	4	4	4	4	4	4
Q(5) p-value	0.88	0.92	0.85	0.86	0.91	0.08	0.56
Q(10) p-value	0.72	0.78	0.76	0.67	0.70	0.23	0.59
Log-likelihood	-1203.63	-1145.88	-1201.02	-1201.76	-1197.90	-824.71	-740.44
Wald test of joint significance (p-value)	0.00 ***	0.00 ***	0.00 ***	0.00 ***	0.00 ***	0.00 ***	0.00 ***

Table 6
Determinants of Term Premia in Argentina

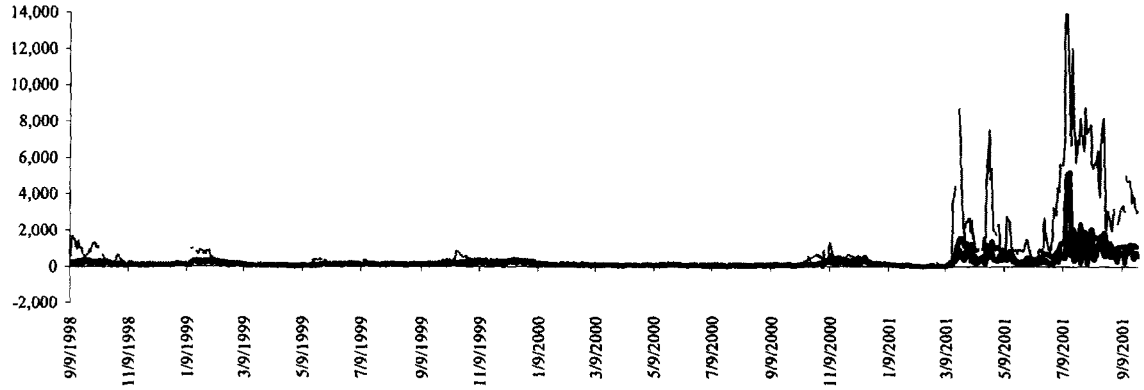
The columns of the table show the results for regressions of the term premium on a set o explanatory variables. Columns 1 to 5 correspond to ordinary least squares (OLS) regressions and columns 6 and 7 extend the model to an exponential garch (EGARCH). The models estimated are described in equations (15) and (16) in the paper. The first column of the table shows the results for the basic specification, including as regressors (i) the US dollar LIBOR term premium, (ii) the spread of a high yield bond index over a comparable U.S. government bond, (iii) the EMBI spread of Latin American countries excluding Argentina, and (iv) the ratio of total reserves of the central bank to total deposits and (v) the ratio of total cash held by the financial system over total deposits. The second specification, column (2), adds the Golman Sachs measure of currency mislignment. Specification (3) disaggregates the reserves of the central bank into the ratio of reserves held in the form of government bonds to total deposits and the ratio of hard currency reserves to total deposits. Specification (4) tests the effect of Argentina's average foreign currency credit rating.
The last OLS specification, in column (5), tests the effects of external and internal shocks on the conditional mean with two dummy variables. The external shocks dummy captures the effect of the Russian default and the Brasilian devaluation, while the internal shocks dummy captures the effects of the internal crisis periods during 1999 and 2001: Financial Times article and presidential elections, Vice president resigns, Changes of Finance Minister, and Cut of international credit. In all OLS specifications 4 lags in differences of the dependent variable and all regressors were included. In the EGARCH specifications the lags for the reserves and cash ratios could be treammed down to two, allowing for a larger sample which improves convergence. The EGARCH specifications use the basic set of regressors and a dummy variable for all crisis (internal and external): column (6) tests for the effects of the crisis dummy in the conditional mean and the last specification, column (7), tests for its effects also in the conditional variance. Standard errors are in parentheses. * significant at 10%, ** at 5%, and *** at 1%.

Dependent Variable In First Differences:	NDF Term Sructure (f12-s)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lagged Dependent Variable	-0.483 ***	-0.508 ***	-0.482 ***	-0.510 ***	-0.523 ***	-0.204 ***	-0.216 ***
	(0.078)	(0.081)	(0.076)	(0.086)	(0.084)	(0.009)	(0.009)
US Term Structure	0.717	0.947	0.686	0.731	0.827	0.227 ***	0.226 ***
	(0.664)	(0.856)	(0.694)	(0.663)	(0.723)	(0.046)	(0.038)
High Yield Spread	-0.622	-1.056	0.006	-1.509	-1.967 *	-0.082	-0.031
	(1.130)	(0.849)	(1.045)	(1.089)	(1.100)	(0.098)	(0.084)
GS Misalignment Measure		0.032					
		(0.133)					
LAC EMBI Spread	-0.104	0.013	-0.209	0.062	0.313	0.139 ***	0.139 ***
	(0.166)	(0.117)	(0.166)	(0.161)	(0.217)	(0.015)	(0.018)
Total Reserves to Deposits Ratio (t-3)	0.237 **	0.317 ***		0.143	0.145	0.017 **	0.019 ***
	(0.098)	(0.095)		(0.113)	(0.120)	(0.007)	(0.006)
Bomd Reserves to Deposits Ratio (t-3)			0.058 *				
			(0.031)				
Hard Currency Reserves to Deposits Ratio (t-3)			0.232 **				
			(0.096)				
Banks' Cash over Deposits Ratio (t-3)	-0.165 ***	-0.173 ***	-0.165 ***	-0.131 ***	-0.256 ***	-0.046 ***	-0.045 ***
	(0.047)	(0.050)	(0.043)	(0.047)	(0.066)	(0.002)	(0.003)
Average Foreign Currency Credit Rating				4.916			
				(3.618)			
External Shocks (Russia and Brasil)					-2.095 **		
					(1.008)		
Internal Shocks					-2.931 **		
					(1.292)		
Crisis Dummy						-0.552 ***	-0.559 ***
						(0.049)	(0.062)
constant	-22.729 *	-18.560	1.253	-45.397 **	-63.063 **	-13.500 ***	-0.523 ***
	(13.448)	(15.735)	(15.732)	(22.529)	(26.537)	(0.288)	(0.079)
time	-0.003		-0.003	0.002	-0.002	0.000	0.000
	(0.004)		(0.004)	(0.004)	(0.004)	(0.000)	(0.000)
earch						0.529 ***	0.478 ***
						(0.069)	(0.079)
arch-abs.						2.051 ***	2.032 ***
						(0.104)	(0.112)
egarch						0.993 ***	0.929 ***
						(0.014)	(0.017)
Crisis Dummy							0.786 ***
							(0.113)
constant						-0.152 **	-13.268 ***
						(0.062)	(1.091)
Number of observations	351	331	351	351	351	415	415
R^2	0.46	0.47	0.47	0.46	0.47		
Maximum number of lags	4	4	4	4	4	4	4
Q(5) p-value	0.48	0.73	0.49	0.44	0.69	0.32	0.88
Q(10) p-value	0.52	0.73	0.56	0.46	0.64	0.67	0.99
Log-likelihood	-1070.58	-1013.29	-1067.26	-1069.79	-1065.11	-694.61	-672.76
Wald test of joint significance (p-value)	0.00 ***	0.00 ***	0.00 ***	0.00 ***	0.00 ***	0.00 ***	0.00 ***

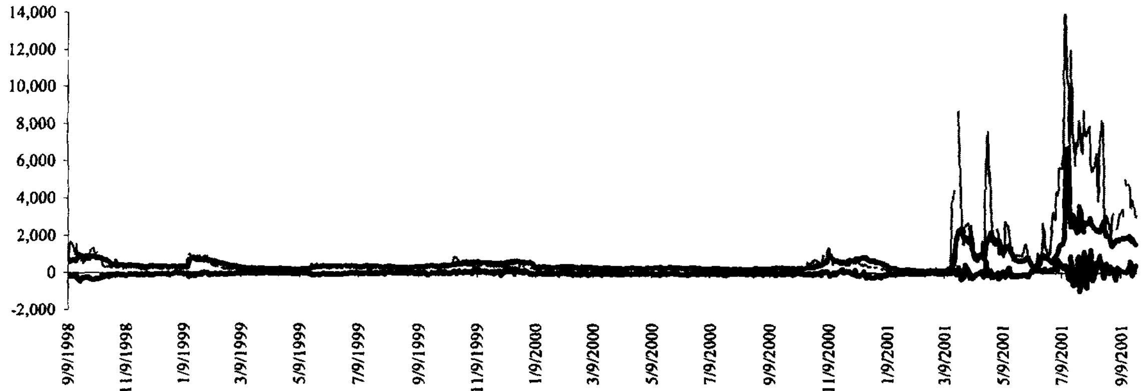
Appendix Figure 1
Non-Deliverable Forward Discount and No-Arbitrage Bands

The figure shows the 1-month Non-Deliverable Forward (NDF) discount and two threshholds defining no-arbitrage bands. The top panel displays the forward discount and two currency premia, the spread between peso and dollar denominated Argentine interbank rates and the spread between peso and dollar Argentine time deposit rates. In the middle panel, the upper threshhold consists of the difference between the interbank offer rate in pesos and the time deposit rate in dollars; the lower threshhold is the difference between the time deposit rate in pesos and the interbank offer rate in dollars. In the lower panel, the upper threshold is the difference between the BAIBOR in pesos and the U.S. deposit rate in dollars; the lower threshold is the spread of the Argentine time deposit rate in dollars over the U.S. Federal Funds Rate. All rates are annualized, in basis points, and continuously compounded. See text for a discussion on arbitrage in case 1, 2 and 3.

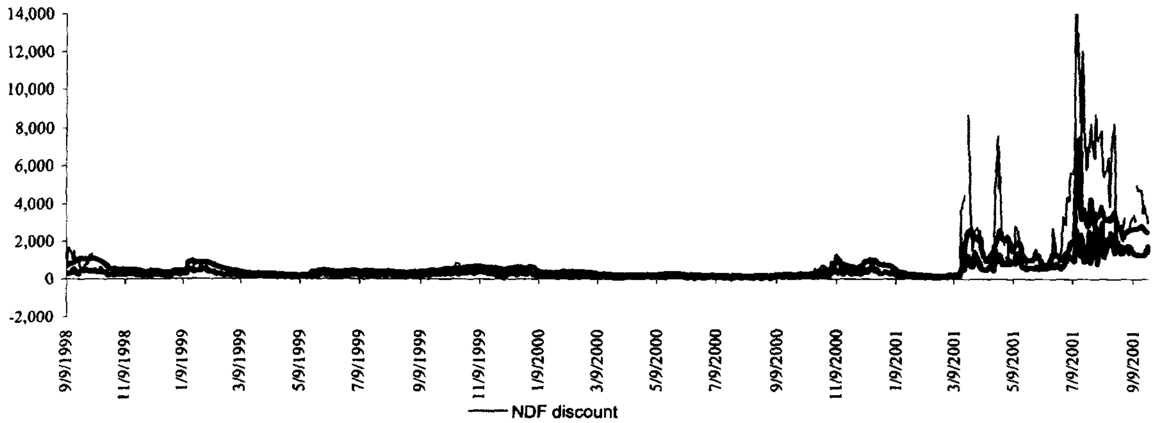
Case 1: $\left(i_{t,k}^{lending} - i_{t,k}^{lending,*}\right) = fd_{t,k} = \left(i_{t,k}^{deposit} - i_{t,k}^{deposit,*}\right)$



Case 2: $\underbrace{\left(i_{t,k}^{lending} - i_{t,k}^{deposit,*}\right)}_{\text{upper band}} \geq fd_{t,k} \geq \underbrace{\left(i_{t,k}^{deposit} - i_{t,k}^{lending,*}\right)}_{\text{lower band}}$

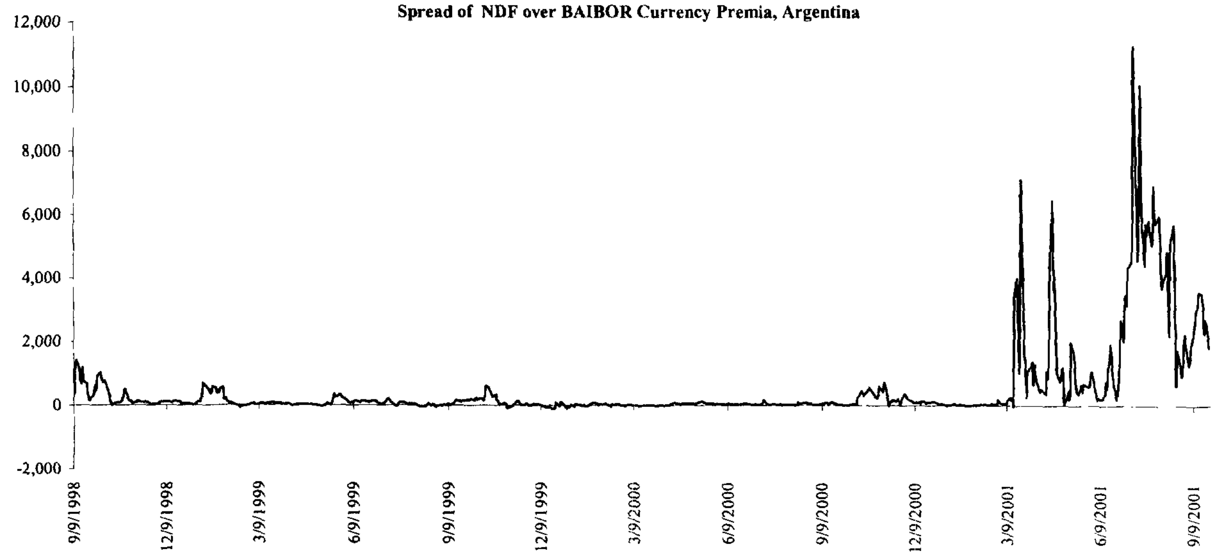


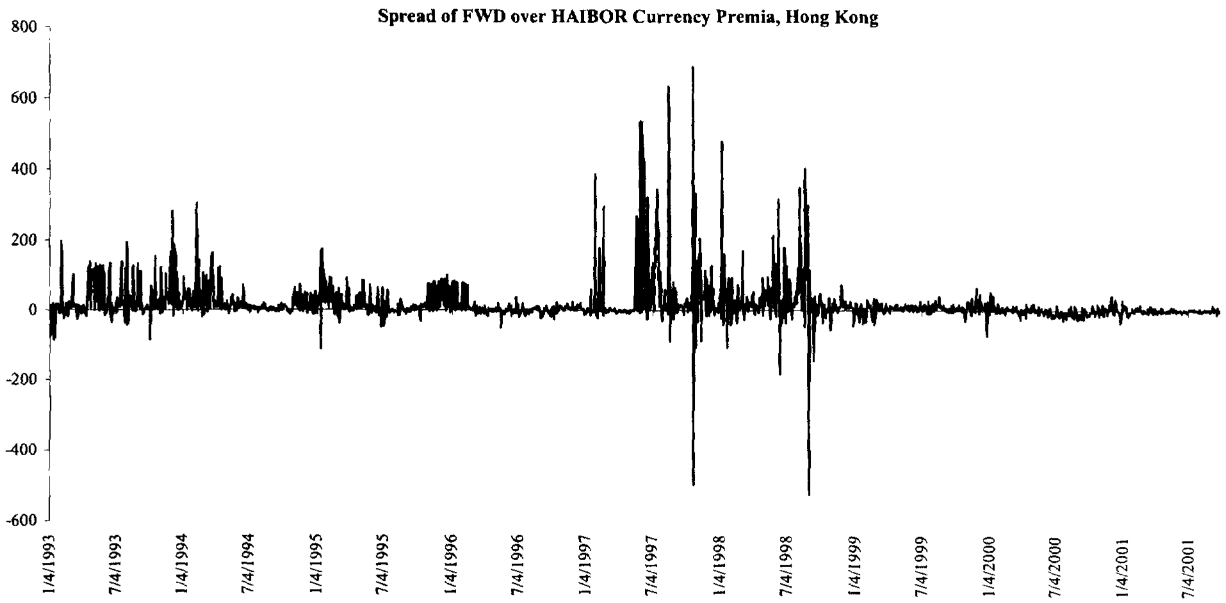
Case 3: $\underbrace{\left(i_{t,k}^{lending} \_ {}^{offshore} i_{t,k}^{deposit,*}\right)}_{\text{upper band}} \geq fd_{t,k} \geq \underbrace{\left(i_{t,k}^{deposit} \_ {}^{offshore} i_{t,k}^{lending,*}\right)}_{\text{lower band}}$



Appendix Figure 2
Cross-Market Currency Premium Differential

The figure shows the spread between the 1-month forward discounts and the interbank currency premium for Argentina and Hong Kong. The interbank rate for Argentina is the interbank offer rate (BAIBOR) obtained from Bloomberg. Since in Hong Kong these rates are denominated only in Hong Kong dollars, the premium is measured by the spread of these over the U.S.-dollar LIBOR. The forward exchange rates for Argentina are non-deliverable forward (NDF) rates obtained from Deutsche Bank and Bloomberg. The forward rates for Hong Kong correspond to deliverable contracts and come from Bloomberg. The interbank rates used for Hong Kong are interbank offer rate (HIBOR), obtained from the Hong Kong Monetary Authority. All the rates are annualized, in basis points, and continuously compounded.





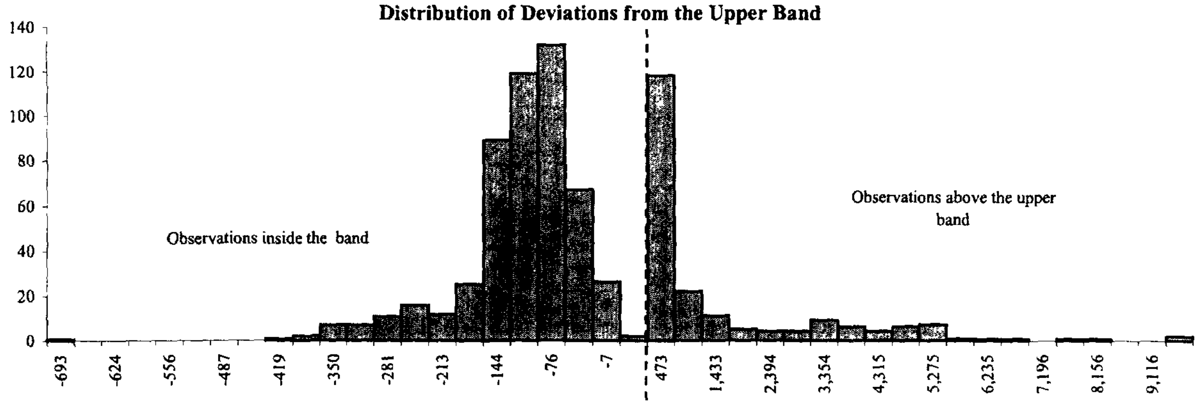
Appendix Table 1
Currency Premia and the No-Arbitrage Band

The top panel shows summary statistics fo the 1-month Non-Deliverable Forward (NDF) discount and two threshholds defining the no-arbitrage band. The upper threshhold consists of the difference between the interbank offer rate in pesos and the time deposit rate in dollars. The lower threshhold is the difference between the time deposit rate in pesos and the interbank offer rate in dollars. The mid panel shows the histogram of the difference between the NDF discount and the upper band. Since there are no observations bellow the lower band, negative observations correspond to observations inside the no-arbitrage band, while positive observations correspond to deviations from the no-arbitrage condition. The lower panel shows econometric estimations of revertion to the no-arbitrage band for observations of the NDF discount outside the band and to the conditional mean for observations of the NDF discount inside the band. All rates are annualized, in basis points, and continuously compounded.

Summary Statistics

	Number of Observations	*Obs. in Percent of Total*	*Mean*	*Median*	*Std. Dev.*	*Min*	*Max*
NDF discout	737	-	857	228	1,772	42	14,726
Upper band	1,098	-	458	287	568	100	6,702
Lower band	1,098	-	-39	-49	148	-1,042	1,253
Obs. above the no-arbitrage band	220	30%	2,380	1,049	2,673	120	14,726
Obs. inside the no-arbitrage band	517	70%	209	150	189	42	2,141

Distribution of Deviations from the Upper Band



Revertion of Forward Discount

$$\begin{cases}\Delta\left(fd_{t,k}-\left(i_{t,k}-i^{*}_{t,k}\right)\right) = c^{out}+\lambda^{out}\left(fd_{t-1,k}-\left(i_{t-1,k}-i^{*}_{t-1,k}\right)\right)+\varepsilon^{out}_{t,k} & \text{if } fd_{t,k}>\left(i_{t,k}-i^{*}_{t,k}\right)\\ \Delta fd_{t,k} = c^{in}+\lambda^{in} fd_{t-1,k}+\varepsilon^{in}_{t,k} & \text{if } fd_{t,k}\le\left(i_{t,k}-i^{*}_{t,k}\right)\end{cases}$$

$$\varepsilon_t^{out}\sim N(0,\sigma^{out}) \text{ and } \varepsilon_t^{in}\sim N(0,\sigma^{in})$$

	Including the "Cut of international credit" crisis period				Excluding the "Cut of international credit" crisis period			
	λ^j	*t-ratio*	*Dickey-Fuller 1% critical value*	*Half-life*	λ^j	*t-ratio*	*Dickey-Fuller 1% critical value*	*Half-life*
outside no-arbitrage band [1]	-0.16	-4.00	-3.49	3.86	-0.45	-7.24	-3.50	1.17
	(0.04)				(0.06)			
inside no-arbitrage band [2]	-0.07	-6.28	-3.44	9.68	-0.07	-6.28	-3.44	9.68
	(0.01)				(0.01)			

1 The half-life corresponds to the convergence to the non-arbitrage band

2 The half-life corresponds to the convergence to the conditional mean

Appendix Table 2
Cross-Market Currency Premium Differential
Summary Statistics

The table shows summary statistics of the spread between the 1- and12-month forward discounts and interbank currency premia for Argentina and Hong Kong, using different samples. The currency premium for Argentina is calculated as the spread of local peso over local U.S. dollar interbank offer rates. The currency premium for Hong Kong is the spread of Hong Kong dollar interbank offer rates over the U.S.-dollar LIBOR. The crisis periods for Argentina are the following: (i) Mexican crisis, (ii) Attack on the Hong Kong dollar, (iii) Russia's default, (iv) Devaluation of the Brazilian real, (v) Financial Times article and presidential elections, (vi) Vice president resigns, (vii) Changes of finance minister, and (viii) Cut of international credit. The crisis periods for Hong-Kong are: (i) The Mexican crisis, (ii) the Financial distress in Korea, (iii) the Attacks on the Thai baht and the four attacks on the Hong Kong dollar. See text for a description of all the events. All rates are in basis points, annualized, and continuously compounded.

	Dates	*Number of Observations*	*Mean*	*Median*	*Standard Deviation*	*Min*	*Max*
Argentina							
NDF-BAIBOR 1-month							
Total	04/21/97-06/05/01	720	509	64	1,319	-109	11,221
Tranquil Periods		392	154	37	493	-105	4,520
Crisis Periods		328	934	183	1,790	-109	11,221
Russia's default	08/19/98 - 10/16/98	27	618	674	377	1	1,407
Devaluation of the Brazilian real	01/13/99 - 02/12/99	22	343	374	225	5	673
Financial Times article and elections	05/17/99 - 12/17/99	141	79	60	109	-109	580
Vice president resigns	10/06/00 - 12/29/00	54	231	158	183	-14	712
Changes of finance minister	03/16/01 - 05/18/01	36	1,651	1,108	1,695	29	7,102
Cut of international credit	07/10/01 - 09/25/01	48	4,147	4,054	2,462	632	11,221
NDF-BAIBOR 12-month							
Total	04/21/97-06/05/01	905	285	161	381	-202	2,252
Tranquil Periods		546	201	142	229	-202	1,340
Crisis Periods		359	413	268	509	-154	2,252
Attack on the Hong Kong dollar	10/29/97 - 11/26/97	13	302	252	126	122	568
Russia's default	08/19/98 - 10/16/98	41	662	654	189	385	1,121
Devaluation of the Brazilian real	01/13/99 - 02/12/99	22	369	369	150	150	730
Financial Times article and elections	05/17/99 - 12/17/99	143	131	68	184	-154	595
Vice president resigns	10/06/00 - 12/29/00	54	141	127	90	-15	362
Changes of finance minister	03/16/01 - 05/18/01	38	374	352	245	-83	916
Cut of international credit	07/10/01 - 09/25/01	48	1,431	1,510	569	-63	2,252
Hong Kong							
FWD-HIBOR 1-month							
Total	01/04/93 - 06/05/01	2,090	18	6	57	-523	688
Tranquil Periods		1,782	11	5	30	-85	306
Crisis Periods		308	57	24	123	-523	688
Mexican crisis	01/10/95 - 04/10/95	59	36	22	48	-111	175
Early signs of financial distress	01/27/97 - 02/21/97	17	53	1	119	-20	386
Attack on the Thai Bath	05/14/97 - 7/24/97	46	131	35	163	-26	535
1st Attack on the Hong-Kong dollar	08/15/97 - 12/15/97	81	44	23	132	-497	688
2nd Attack on the Hong-Kong dollar	01/05/98 - 02/04/98	19	61	44	132	-106	481
3rd Attack on the Hong-Kong dollar	05/27/98 - 07/06/98	28	46	26	94	-181	317
4th Attack on the Hong-Kong dollar	07/10/98 - 10/06/98	58	46	26	120	-523	404
FWD-HIBOR 12-month							
Total	01/04/93 - 06/05/01	2,106	-5	-3	28	-833	150
Tranquil Periods		1,795	-4	-3	14	-69	99
Crisis Periods		311	-12	-9	66	-833	150
Mexican crisis	01/10/95 - 04/10/95	60	-24	-18	30	-194	43
Early signs of financial distress	01/27/97 - 02/21/97	18	-9	-10	8	-22	5
Attack on the Thai Bath	05/14/97 - 7/24/97	46	-13	-13	8	-32	1
1st Attack on the Hong-Kong dollar	08/15/97 - 12/15/97	81	-29	-8	110	-833	150
2nd Attack on the Hong-Kong dollar	01/05/98 - 02/04/98	20	4	19	60	-140	89
3rd Attack on the Hong-Kong dollar	05/27/98 - 07/06/98	28	16	13	31	-43	88
4th Attack on the Hong-Kong dollar	07/10/98 - 10/06/98	58	4	3	49	-257	136

Appendix Table 3
Data Description

	Description	*Maturiy*	*Sample*	*Source*
Argentine data				
Non-deliverable forward exchange rates (NDF)	Pesos per U.S. dollar; for some dates the rates are reported as points for others as outright.	1 and 12 months	9/9/98-9/25/01 (1-month) 10/20/97-9/25/01 (12-month)	Bloomberg (1 and 12 months from 9/9/98); and Deutsche Bank (12-month before 9/9/98)
Spot exchange rate	Pesos per U.S. dollars	-	10/20/97 - 9/25/01	Bloomberg
Interbank offer rates in pesos and dollars (BAIBOR)	Annualized rate	1 and 12 months	4/21/97 - 9/25/01	Bloomberg
Time deposit rates in pesos and dollars	Annualized rate	1 month and up to 2 months	1/4/1993 - 6/5/01	central bank of Argentina
Interbank deposit rates in pesos and dollars	Annualized rate	1 month	1/13/1995 - 9/25/01	Bloomberg
Total reserves of the central bank	Total reserves held by the central bank of Argentina (government bonds and hard currency, U.S. dollar, billions)	-	12/29/1994 - 9/25/01	Bloomberg (original source: central bank of Agentina)
Bond reserves of the central bank	Reserves in Argentine government bonds, (U.S. dollar, billions)	-	12/29/1994 - 9/25/01	Bloomberg (original source: central bank of Agentina)
Hard currency reserves	Reserves in hold, currency and short and long-term deposits (U.S. dollar, billions)	-	12/29/1994 - 9/25/01	Bloomberg (original source: central bank of Agentina)
Total deposits of the financial system	Total Argentine bank deposits (U.S. dollar, millions)	-	12/29/1994 - 9/25/01	Bloomberg (original source: central bank of Agentina)
Total cash holdings of the financial system	Cash holdings (effectivo) in local and foreign currency (U.S. dollars, millions)	-	12/29/1994 - 9/25/01	Bloomberg (original source: central bank of Agentina)
Hong Kong data				
Deliverable forward exchange rate (FWD)	Hong Kong dollars per U.S. dollar	1 and 12 months	1/4/93 - 9/25/01	Bloomberg
Spot exchange rate	Hong Kong dollars per U.S. dollar	-	1/4/93 - 9/25/01	Bloomberg
Interbank rate in Hong Kong dollars (HIBOR)	Annualized rate	1 and 12 months	1/4/93 - 9/25/01	Hong Kong Monetary Authority
International data				
U.S. Federal Funds rates (FFR)	Annualized rate	1 month	1/4/93 - 9/25/01	Bloomberg
U.S. Deposit rates	Annualized rate	1 month	9/25/96-9/25/01	Bloomberg
U.S. Treasury bill rates	Annualized rate	3 and 12 months	1/4/93 - 9/25/01	Bloomberg
U.S. dollar LIBOR	Annlualized rate	1 and 12 months	1/4/93 - 9/25/01	Bloomberg
High yield spread	Spread of Moody's junk bond index over the U.S. 30-year government bond yield	-	1/4/93 - 9/25/01	Bloomberg
EMBI spread for Latin American Countries	Weighted average of the EMBI spreads of Latin American countries excluding Argentina, using 1999 GDP weights	-	1/4/93 - 9/25/01	JP Morgan

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